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Power Generation

October, 1948

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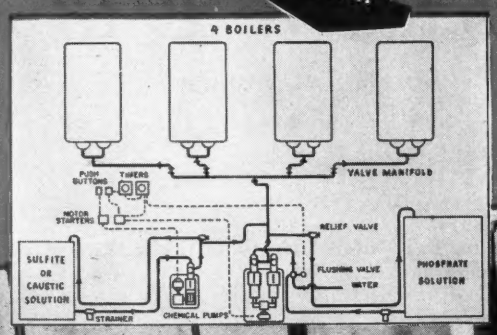
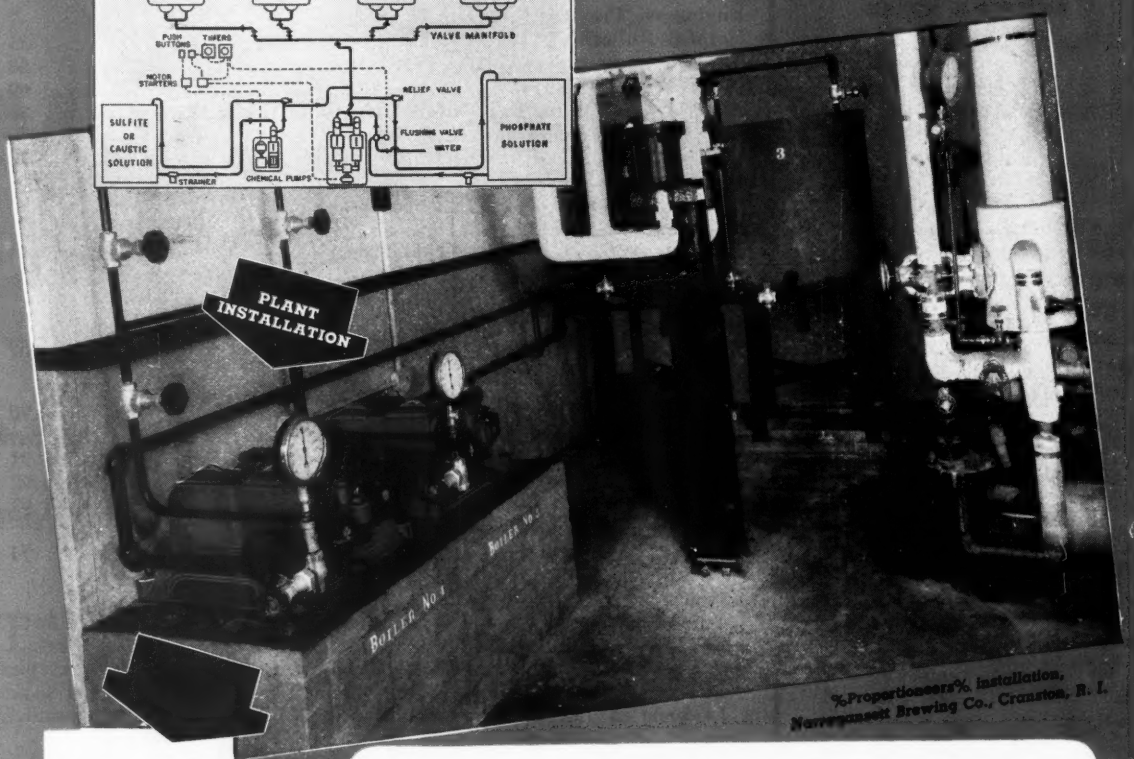
A *Working* PRINCIPLE FOR *Correct* BOILER WATER CONDITIONING





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BOILER WATER CONDITIONING WILL WORK FOR *You*

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ENGINEERS' PREVIEW

CARNATIONS — or at the very least, a bronze plaque — for an outstanding feature in a new Water Test Manual recently issued. The manual presents detailed directions for making each of the control tests used in water conditioning. These include not only the standard chemical tests, but also use of the various types of color comparators, measurement of steam condensate by electrical conductivity methods, and the like. The publication is loose leaf, each test on an individual page, with illustrations and concise but very clear directions for making the test — none of the chemistry or theory.

The feature is that, in the directions for each chemical test, (P Alkalinity, MO Alkalinity, Chloride and Sulfite and so on) the illustrations show the exact colors of the samples or solutions after adding reagents and the colors at the end points. This, it seems to us, should be of great value to the engineers right on the boiler room floor who must learn how to run these tests.

Most of the tests have previously been described in *Power Plant Engineering* and *Power Generation*, by such authorities as Wright and Fleming. Readers will remember E. P. Davis' well-illustrated article on the standard chemical tests in *Power Plant Engineering* in 1946, and in the May 1948 issue of *Power Generation*, Mr. McCrumb's explanation of the use of color tests. But in half-tone reproductions, it is very difficult and expensive to get exact color reproductions of chemical tests; that's why it has seldom been done and that's what makes this a top job of technical presentation.

Many of us editors have seen 90 per cent of the manufacturers' catalogs develop in 25 years from typographical nightmares containing very little information to well-designed good-looking books crammed with technical data elsewhere unobtainable. Since most of them are now so good, it's all the more difficult to do something in a catalog that stands out.

Well, we can't keep it from you any longer — it's Dearborn Chemical Company that has issued this Water Test Manual. (As if we didn't intend all along to tell you!)

★ ★ ★

UTILIZING the present typewriter tabular key as a justifier and adding a reel of special paper tape, Joseph Spielvogel claims to have solved a problem that has frustrated engineers for over a century. Among others, Mark Twain spent a fortune on this problem without success. According to the inventor, as described in *Editor & Publisher*, the Vogel-Reel provides the only available means for producing automatically aligned columns on a typewriter without any preliminary copy calculation or other preparatory steps.

The reel is mounted parallel with the typewriter ribbon and the tape is fed past the typing point by a left margin gripper on the carriage. When no more words or divisions will fit on the line, the tabular key is depressed. This performs the same function as the justifying key on the linotype, causing a stationary right margin tape gripper to close while the carriage slides to its predetermined stop, thereby stretching the line to its desired equal width. The machine then cuts off and sticks the finished line to a paper galley and the operation is repeated with each line.

The copy is, of course, suitable for production by offset, stereotype, gravure and other processes used in printing.

BRAIN TEASER — It seems that some lucky stiff went into a bank recently and cashed a check for X dollars and Y cents, and the paying teller handed him Y dollars and X cents. After spending $3.50 of his ill-gotten gains, the lucky stiff found he still had twice as much money as the check originally called for. Now let's see you figure out the values of X and Y.

This one was sent in by Milton Peppin, of the Santa Fe Railway, to Sparling *Metrograms*, from which we swipe it with mucho gusto and con grazia—if you'll pardon the expression. Bet they and we will hear something about this from some bank, which will point out in its most courteous and dignified manner that no teller ever makes a mistake like that. Even if he did, would the guy get out of the bank with the Y dollars and X cents before somebody discovered it? You might try calculating his chances on that one too.

★ ★ ★

FORTY-SIX scholarships and loans totaling $13,150 have been granted by the General Electric Co. to its employees and children of employees for undergraduate study in the 1948-1949 school year. Recipients of the scholarships and loans were selected on a competitive basis.

★ ★ ★

COMPOSITE AVERAGE retail price for bituminous coal stood at $15.11 per ton of 2,000 lb. in May, 1948, based on the unweighted average of 21 cities, according to the latest report from the Bureau of Labor Statistics, U. S. Department of Labor. In May, 1947, the corresponding price was $12.09 per ton. Detailed tabulation of these prices by years and also by various cities throughout the country are given in the report.

★ ★ ★

AGREEMENT among Upper Basin States of the Colorado River with respect to division of river waters was reported in July by Secretary of the Interior J. A. Krug. He stated that firm agreement has been reached by Colorado, New Mexico, Utah, Wyoming and Arizona with regard to the division of the waters allotted to them from the Colorado River. This, he states, will clear the way for the Secretary of the Interior, through the Bureau of Reclamation, to proceed to the actual development of the main stream reservoirs of the Upper Basin. This will result in provision of power, irrigation water and storage to meet the needs of the lower basin. It will not be necessary, says Secretary Krug, to lay the river away in cotton batting while the fight continues over who is going to use what water where. He congratulated Commissioner Bashore and every member of the Colorado Upper Basin States Commission on the job they have done.

★ ★ ★

PROCEEDINGS of the National Conference on Industrial Hydraulics, including papers presented to the 3rd Annual Meeting in Chicago, October 1947, are now available in book form. The publication includes papers on Hydraulic Control, Cavitation, Automotive Transmissions and Industrial Applications. Copies may be obtained by remitting purchase price of $3.00 per copy, or sending properly authorized purchase order, to S. S. Musselman, Conference Secretary, Armour Research Foundation, Technology Center, Chicago 16, Ill. Make checks payable to Armour Research Foundation.

SCIENCE STUDENTS must no longer be allowed to think of themselves as excused from social responsibilities on the grounds that, like medieval scholastics, they are dealers in mysteries beyond the ken of common men. So says Dr. Edwin S. Burdell, Director of The Cooper Union and Chairman of the Humanistic-Social Studies Division of the ASEE, in the preface of an annotated bibliography on The Humanistic-Social Stem of Engineering Education, just published by The Cooper Union. The scientific professions have become conscious that they are, indeed, dealers in the life and death of mankind. Just as the United States Government is discovering and accepting its world position, so a!so are the country's citizens and the professional schools, which emphasize that scientists and engineers must also be citizens.

★ ★ ★

LATEST BOON to exhausted executives and tired office workers, who haven't the strength to push an elevator call button, is the new development in elevator controls recently announced by Otis. In the new control, all you have to do to summon the most modern elevator is simply to touch the control button on the landing. You don't even need to push it; in fact, the button won't push anyway. In the new method, the electricity in the touch of the finger is harnessed—it says here—and put to work to stop the elevator at a given floor. The operator inside has similar contro! buttons. The first commercial insta'lation of the new control is in the Universal Pictures Building at 445 Park Avenue, New York. Principal feature of the control which the passenger doesn't see is that it cuts the necessary control wiring in elevator systems to about one-half of the former requirements.

★ ★ ★

FOR A LONG TIME, engineers at engineering conferences and conventions have been sitting in dark meeting rooms, watching lantern slides projected (with more or less efficiency) on a screen, while the speaker, back to the screen, tried to deliver his paper into a fixed microphone, facing his audience. Under such conditions, the complete elimination of the speaker's voice as he turns from the microphone to explain something on the screen has become a standard phenomenon.

Engineers have wondered, therefore, why a really effective reflecting projector could not be produced that would permit the speaker to continue facing his audience and his microphone, and to look at his illustration while it was being reflected over his head onto the screen behind him.

Well, there is at least one device now on the market —the Vu-Graph—designed to do exactly that. Another device called the Delineascope is designed to do the same thing; but we have no information about it except that it will handle an illustration 6 by 6 in. in size.

The Vu-Graph is designed to project a 7 by 7 in. horizontal picture or drawing made on any transparent material (such as lantern slides, plastic or film) on a screen behind the speaker. Provision is made for using a special plastic on which the speaker can make sketches as he talks, which are projected on the screen as he makes them. Then, of course, he can point with a pencil or small stylus to the drawing in front of him and his point is shown on the magnified image on the screen. It seems that some such device as this, together with a lapel or shoulder microphone for the speaker, would tremendously simplify the technique of presenting technical papers before engineering groups.

MODERN POWER PLANT and industrial processes often require the measurement of liquid level in containers under pressure above atmospheric, often as a basis for automatic control. The differential-pressure type mercury manometer, as commonly used in flow measurement, is widely employed for such service because it is ideally suited to measure the difference between the static pressure in the vessel and the pressure resulting from the column of liquid. The fundamental principles of such measurements and how they are adapted to determining liquid levels in a wide variety of measuring and control devices, are discussed in detail, with many illustrations, by C. F. Cusick and S. D. Ross in an article Technique of Measuring Liquid Level in Vessels Under Pressure in *Instrumentation*, Volume 3, No. 3.

★ ★ ★

ABSTRACTS of 358 United States patents formerly owned by nationals of enemy countries and seized by the Department of Justice, Office of Alien Property, since November, 1945, are now on sale by the Office of Technical Services, Department of Commerce. Most of the patents are available for licensing to American firms by the Office of Alien Property on a royalty-free, non-exclusive basis for the remaining life of the patents.

Specific items of interest include a method for producing acetylene and carbon black; an electric-motor starting device; an electrical musical instrument; an outdoor display system; a compensating arrangement for television tubes; a mercury-containing storage battery; a system for manufacturing carbonated milk beverages; a multiple-cell exposure meter; a hydraulic transmission gear; an internal-combustion engine that can be mounted on a bicycle wheel; a multiple film-roll camera; an automobile-carrying freight car; and a pin for the temporary fastening of buttons.

Copies of the compilation (Report PB-88841, List of Vested Patents Available from Office of Alien Property, 85 pages) sell for $4. Orders should be addressed to the Office of Technical Services, Department of Commerce, Washington 25, D. C., accompanied by check or money order payable to Treasurer of the United States. Copies of the patents may be examined in Room 1325, Commerce Building, Washington, D. C.

Concerning licensing of enemy patents, address the Office of Alien Property, Department of Justice, Washington 25, D. C. Copies of individual patents by number, may be purchased only from the Commissioner of Patents, U. S. Patent Office, Washington 25, D. C., for 25 cents each.

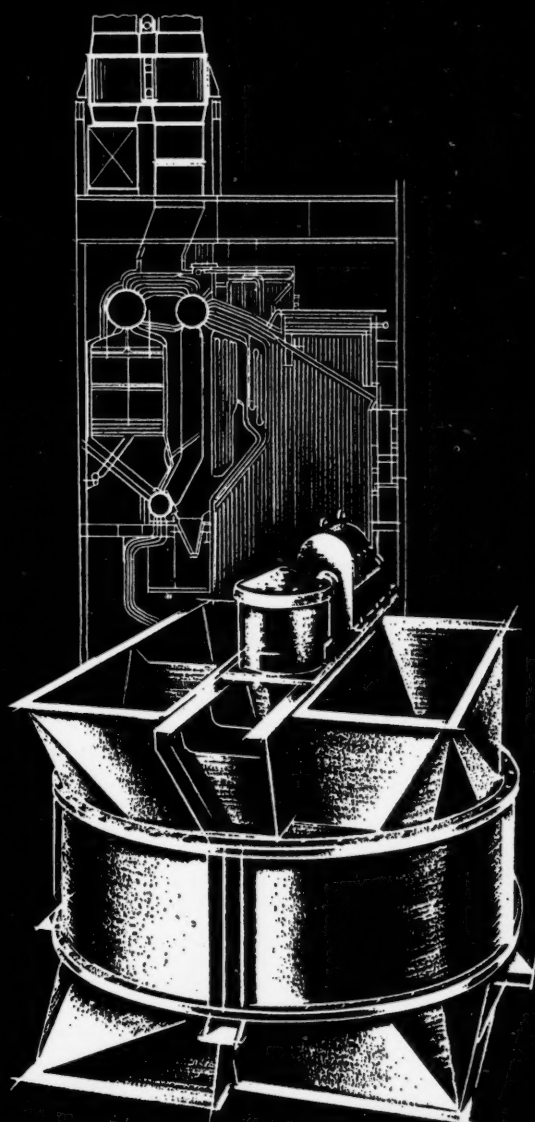
★ ★ ★

HERESY or insubordination—or something—again rears its ugly head! Lighting standards set for school, industries, offices and homes are often too high, according to an article in the current issue of the *Optical Society of America*. The article reports research at the University of Minnesota's Laboratory of Physiological Hygiene reveals that Minnesota's scientists have found the best level for a very strenuous type of visual work was between 50 and 100 ft candles and actually the performance at 300 ft candles was slightly below the value for 50 ft candles. The article suggests that 100 ft candles is enough for many places where 300 to 500 are called for in lighting codes.

Well, maybe so. But this writer has always demanded lots of light for writing and reading; and when the light isn't good he either doesn't read or takes the work to a good light. Maybe—or maybe not—that's why, at the age of 53, he reads 6 pt type and up without glasses —has never worn them, in fact. Or perhaps that's just due to his old Scotch grandparents. We dunno.

Designed for Preheat

when high-temperature air is essential



With the Ljungstrom Air Preheater, it is possible to supply high-temperature preheated air for combustion or processes.

While plans for steam generation plants are under consideration investigate the possibilities of the Ljungstrom. The specialized experience of Air Preheater engineers is at your disposal, to aid you in effecting the most economic heat recovery from flue gases.

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A *New* YARWAY AID TO . . .

BETTER POWER

HI-LO-GRAPH LIQUID LEVEL RECORDER

Permanent, hour-by-hour records of boiler water levels can be charted with the new Yarway Hi-Lo-Graph.

The Hi-Lo-Graph not only *records* . . . it also *indicates* boiler water level changes. Brightly lighted active section of the chart makes pen arm clearly visible as indicator.

Indication is *instant* and *accurate* because the Hi-Lo-Graph is operated by the boiler water itself. No stuffing boxes. Actuating mechanism is never under pressure.

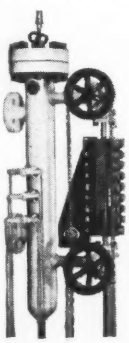
Easily installed on new or existing boilers. Designed for wall or panel mountings. For all pressures up to 2500 psi.

For complete description, write for new Yarway Bulletin WG-1830.

YARNALL-WARING COMPANY

114 Mermaid Ave., Philadelphia 18, Pa.

OTHER YARWAY LIQUID LEVEL INDICATING EQUIPMENT



WATER COLUMNS AND GAGES

Yarway columns feature the *floatless* Hi-Lo-Alarm Signal. Two types of gages—Sesure Inclined and Vertical Flat Glass. Write for Catalog WG-1811.

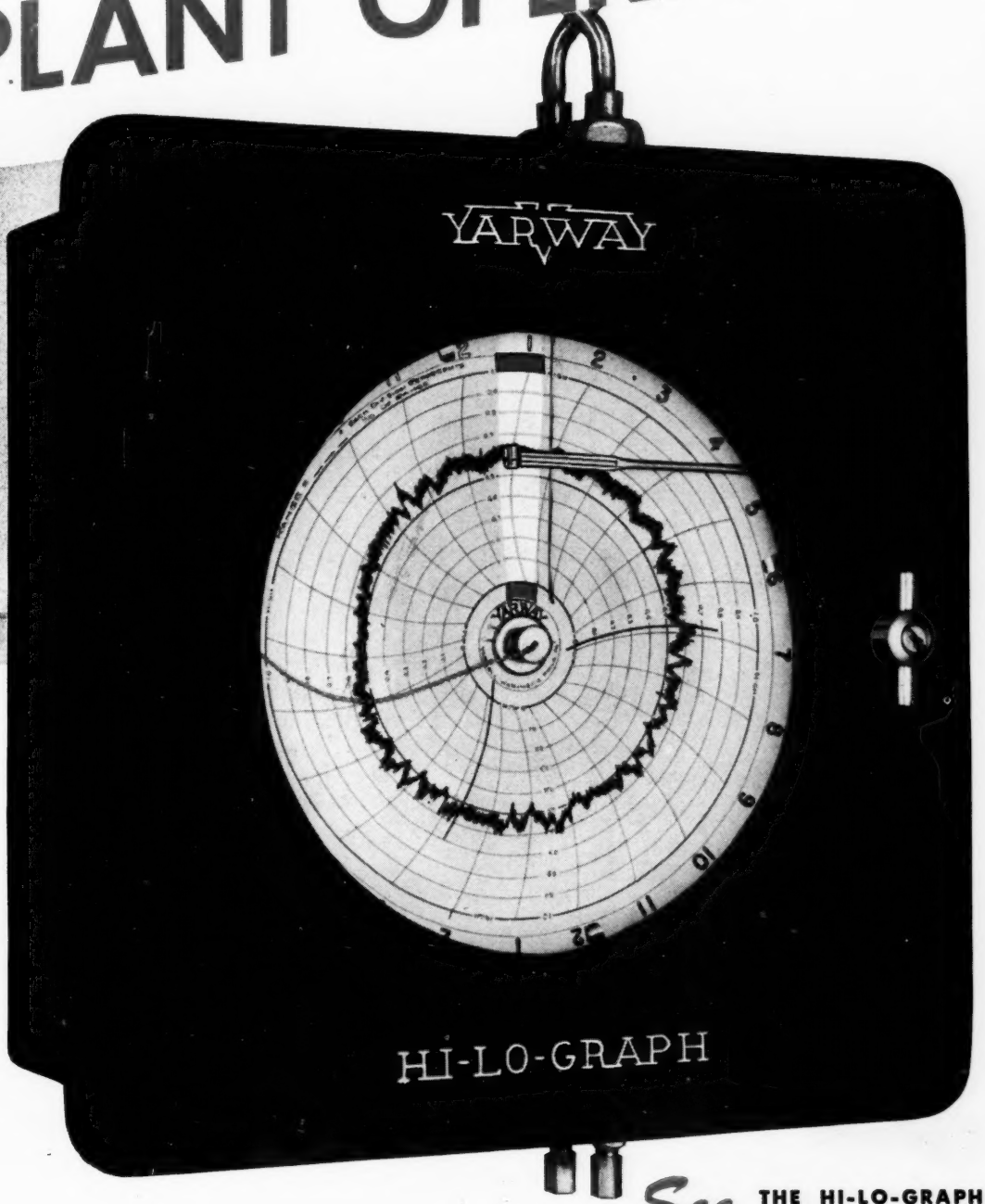
REMOTE LIQUID LEVEL INDICATOR

Brings overhead gage readings right down to eye level—on instrument panel or other convenient place. *Instant, accurate* indication. Completely described in Catalog WG-1822.

REMOTE HORN AND LIGHT SIGNAL ALARMS

Operated anywhere in power plant by Control Unit located on YarwayRemote Liquid Level Indicator. Completely described in Catalog WG-1822.

PLANT OPERATION



See THE HI-LO-GRAPH AND OTHER YARWAY EQUIPMENT AT THE NATIONAL POWER SHOW, NEW YORK, NOV. 29 TO DEC. 4 — BOOTHS 65 AND 66

YARWAY **POWER PLANT EQUIPMENT**

NEW ENGLAND MUTUAL LIFE
holds down overhead costs with

Home Office of New England Mutual Life Insurance Company, Boston, Massachusetts.

K&M "FEATHERWEIGHT" 85% MAGNESIA INSULATION

(Above) Steam lines are insulated with K&M "Featherweight" 85% Magnesia.

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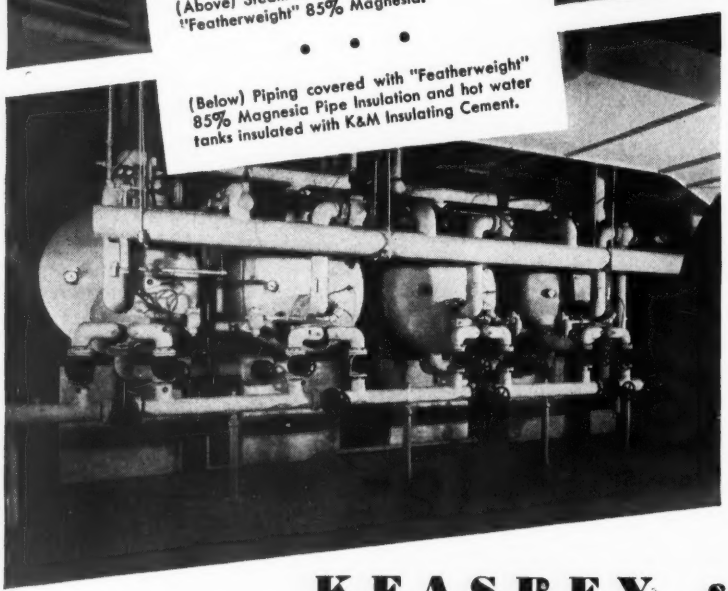


(Below) Piping covered with "Featherweight" 85% Magnesia Pipe Insulation and hot water tanks insulated with K&M Insulating Cement.

This imposing home office of the New England Mutual Life Insurance Company, Boston, is supplied with heat from a central heating plant.

The steam pipes are insulated with K&M "Featherweight" 85% Magnesia with the net result that heat losses are reduced to a minimum.

"Featherweight" 85% Magnesia insulation, first manufactured by K&M 62 years ago, combines the high insulating properties of basic Carbonate of Magnesia with Asbestos Fibre as a binding agent, forming a featherlight, fireproof, efficient insulating material.

K&M Distributors, located strategically throughout the country, are experts on the application of K&M insulation materials . . . and can point the way to savings for you. Write us for further information.

DIAMOND ANNIVERSARY 1873 K&M 1948 KEASBEY & MATTISON CO.

Nature made Asbestos . . .
Keasbey & Mattison Company has made it serve mankind since 1873.

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

IN CANADA — ATLAS ASBESTOS CO., LTD., MONTREAL, TORONTO, WINNIPEG AND VANCOUVER

20,000

1884 1948

A RED-LETTER DAY
64 YEARS IN THE MAKING

On August 17, stoker sales of Combustion Engineering and its predecessor companies totalled 20,000 units — an average of more than one stoker *every working day since 1884.*

When you consider that choosing a stoker involves the evaluation of many factors . . . complex factors such as boiler design, fuel characteristics, type of load and the like . . . and when you multiply these variables by 20,000 . . . then only can you realize the breadth of experience which C-E brings to the selection of a stoker exactly suited to your requirements. It is an accumulated experience unmatched by any other manufacturer.

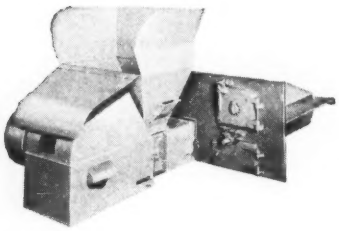
...MOREOVER

C-E

COMBUSTION ENGINEERING

C-E has no

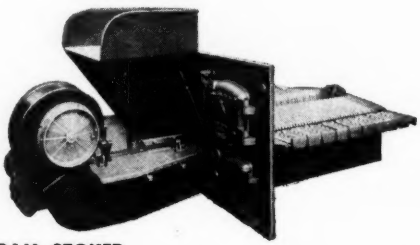
Coupled with C-E's unparalleled breadth of experience is the added advantage of a *complete* line of stokers, which includes every basic type – thus eliminating the possibility of bias, or the need for compromise, in meeting your requirements.



SKELLY STOKER UNIT

Approximate Application Range — 20 to 200 boiler hp.

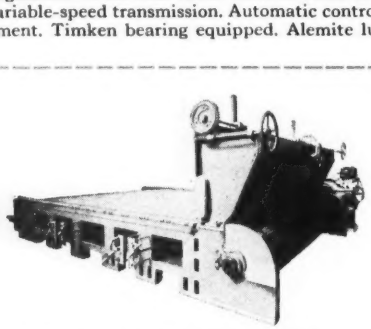
A compact, self-contained underfeed unit available in designs for burning either anthracite or bituminous coal. An alternate arrangement of fixed and moving grate bars assures lateral distribution of fuel and maintains a clean porous fire. Cantilever dump grates of non-avalanching type simplify ash removal. An integral forced-draft fan, with inlet damper control, permits positive regulation of air-coal ratio. Sixteen rates of coal feed through variable-speed transmission. Automatic control is standard equipment. Timken bearing equipped. Alemite lubrication.



LOW RAM STOKER

Approximate Application Range — 35 to 200 boiler hp.

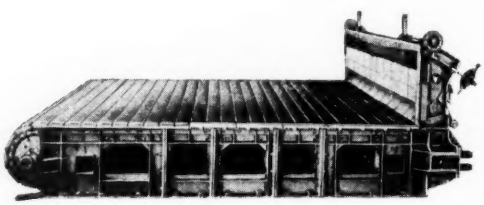
A ram-type underfeed stoker equipped with integral forced-draft fan and drive mechanism. It is designed to burn either free-burning or caking bituminous coals. Since the stoker body is only 16 inches high, the C-E Low Ram Stoker is ideally suited for installation under low-set, water-leg boilers where headroom and furnace volume are limited. Its unit construction assures quick and easy installation at minimum cost. In most applications, it can be set directly on the boiler room floor, requiring no special foundation work.



TRAVELING GRATE STOKERS (Chain Grate)

Approximate Application Range — 150 rated boiler hp. up to largest units suitable for stoker firing.

The chain grate stoker derives its name from the character of its grate surface, which is comprised of small link castings held together by through rods to form a continuous flexible chain. Special driving links, located at intervals across the width of the stoker, engage a series of driving sprockets carried on the front shaft. C-E Chain Grate Stokers include the well-known Green Chain Grates, of which about 4300 have been installed under boilers with an aggregate heating surface of over 10,000,000 sq. ft. C-E Chain Grate Stokers are available in both forced- and natural-draft designs and are well suited to the use of free-burning bituminous coals.



TRAVELING GRATE STOKERS (Bar Grate)

Approximate Application Range — 150 rated boiler hp. up to largest units suitable for stoker firing.

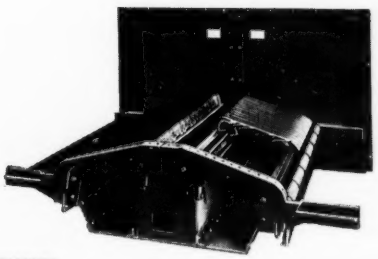
These stokers are of the bar-and-key type, so called to describe the construction of the grate surface. This consists of small castings supported by transversely arranged grate bars carried by sprocket-driven chains. The C-E Coxe Stoker is the most widely known traveling grate in the field, more than 2400 having been installed under boilers with an aggregate heating surface of more than 11,000,000 sq. ft. It has no equal for burning the small sizes of anthracite and coke breeze and is well suited to lignite and some free-burning bituminous coals. C-E bar type traveling grates are forced-draft stokers with the entire grate surface under zoned air control.

C-E

COMBUSTION

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS. ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

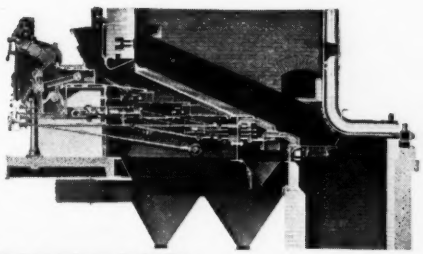
axe to grind



TYPE E STOKER

Approximate Application Range — 150 to 600 boiler hp.

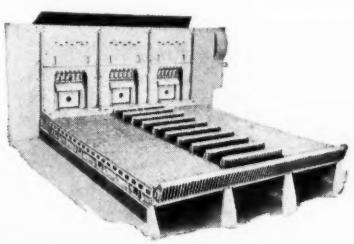
A single-retort, underfeed stoker designed to burn a wide variety of bituminous coals, particularly those having caking and coking characteristics. The Type E has ram type feed supplemented by a reciprocating sliding bottom. Its grate surface consists of hollow, air-cooled grate bars arranged in an alternately fixed and moving relationship to condition the fuel bed and assure its steady movement to the dump trays which are of the cantilever type. Air supply is under zoned control with provision for introduction of air over the fire. Type E Stokers are available with steam, electric or hydraulic drive.



MULTIPLE RETORT STOKER

Approximate Application Range — 500 boiler hp. up to largest units suitable for stoker firing.

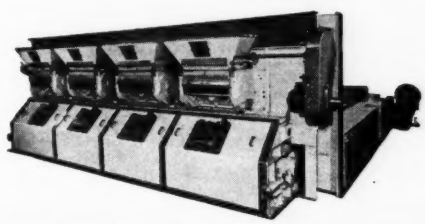
A multiple-retort underfeed stoker designed to burn either caking or free-burning bituminous coals. C-E design has superior features, such as — all controls grouped in front of the stoker, effective sealing against siftings, reciprocating overfeed section, zoned air control, ability to maintain a uniform fire and effective ash discharge. The stroke of the secondary rams and of the overfeed section in each retort is adjustable, as a group or individually. The speed of the main rams and control of the zoned air supply are all conveniently arranged at the stoker front.



SPREADER STOKER (Dumping Grate Type)

Approximate Application Range — 150 boiler hp. up to units producing 150,000 lb of steam per hr, or more.

This simple, rugged stoker is designed to burn a wide variety of coals. Hopper, feeding and distributing mechanism, variable-speed drive and motor are combined in a compact unit. A series of rotating spreader blades feeds coal into the furnace in criss-crossing streams which assure uniform distribution. Fines are burned in suspension and the rest of the coal is burned on the grate. Grate surface is zoned for regulating air admission and to facilitate cleaning. All parts subject to wear are readily accessible for inspection, adjustment or replacement, when necessary. Rate of fuel feed and air supply may be regulated over a wide range and are readily adaptable to automatic control.



SPREADER STOKER (Continuous Discharge Type)

Approximate Application Range — 50,000 lb of steam per hr, or less, to largest units suitable for stoker firing.

The C-E Continuous Discharge Spreader Stoker is actually two stokers in one. It combines the feeding and distributing advantages which characterize the dumping grate spreader with the smoothly operating, continuous ash disposal achieved by the addition of a traveling grate. This stoker permits the burning of more fuel per foot of furnace width than the dumping grate type, thus extending the advantages of spreader stoker firing to larger boilers. The uniformity of fuel-bed and furnace conditions, plus continuous and automatic scavenging of ash from the fuel bed, simplifies stoker operation and reduces attendant labor to a practical minimum.

...CONSIDER ALSO

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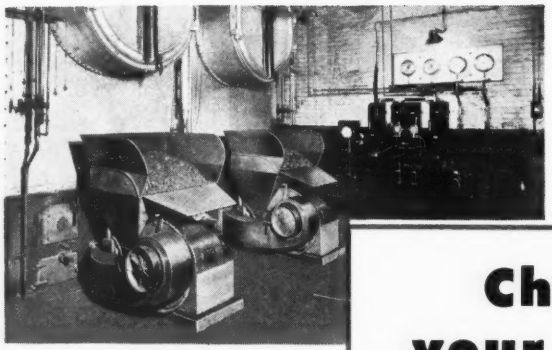
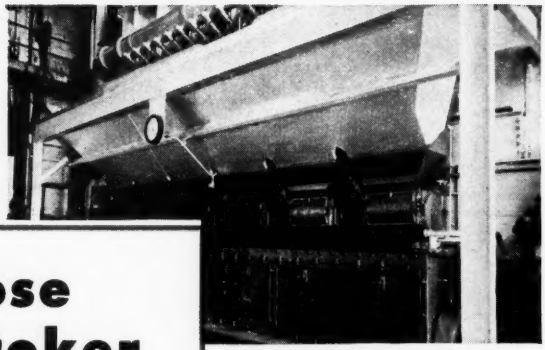




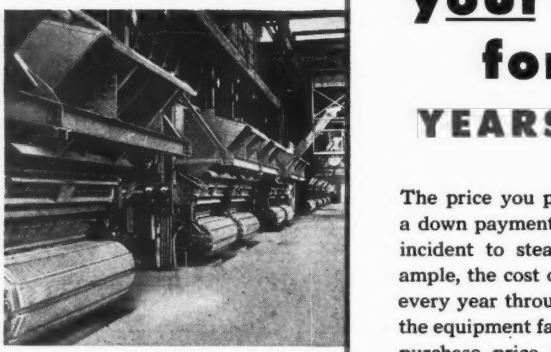
Choose your stoker for the YEARS AHEAD

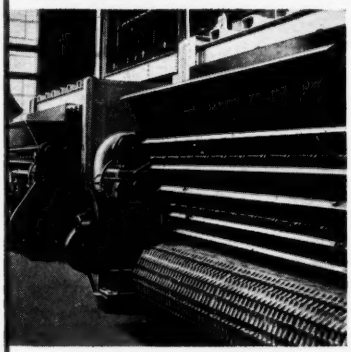
The price you pay for a stoker is only a down payment on the continuing cost incident to steam generation. For example, the cost of fuel burned each and every year throughout the useful life of the equipment far outweighs the original purchase price of the stoker. And, at today's coal prices this fact is of paramount importance to you.

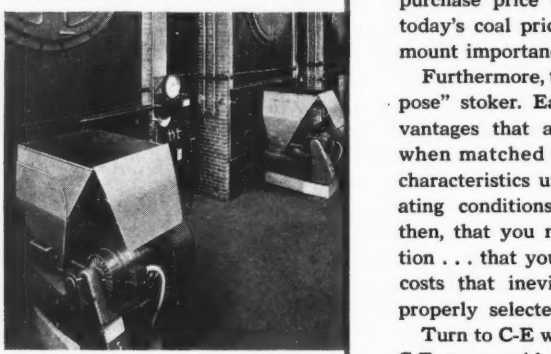
Furthermore, there is no "general purpose" stoker. Each basic type has advantages that are realized fully only when matched with coals of definite characteristics under well-defined operating conditions. How essential it is, then, that you make the correct selection . . . that you avoid the pyramiding costs that inevitably result from improperly selected equipment.

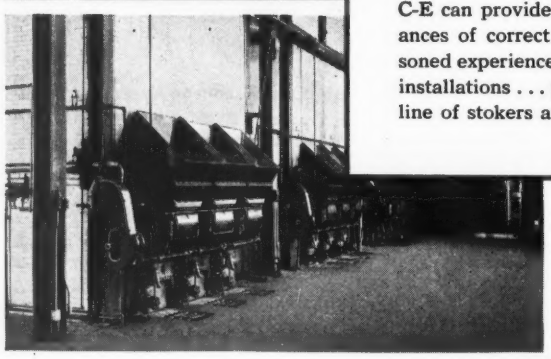
Turn to C-E with confidence, for only C-E can provide these important assurances of correct selection . . . the seasoned experience of 64 years and 20,000 installations . . . plus the most complete line of stokers available anywhere.

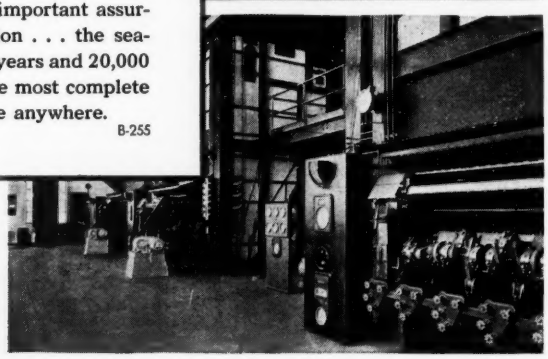
B-255





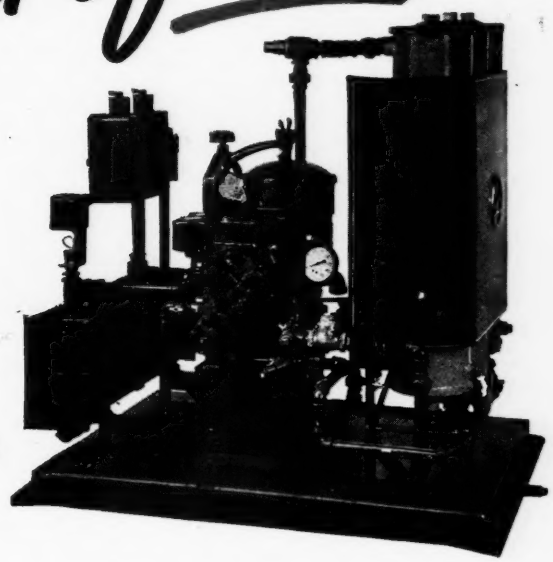






C-E COMBUSTION ENGINEERING

To Get Rid of All LUBE OIL IMPURITIES—



TO remove ***all three*** major contaminants of Diesel lubricating oil, use the De Laval "Puri-Filter." The first two, dirt and water, are separated from the oil by De Laval Centrifugal Force, as embodied in the bowl of the De Laval Oil Purifier. The water is discharged continuously from the Purifier bowl. The third—colloidal carbon—is filtered out of the purified oil by Fram Filters.

The De Laval "Puri-Filter," which is a combination of De Laval "Uni-Matic" Oil Purifier and Fram "Filcron" Filters, gets rid of all solid impurities down to one micron in size. It likewise keeps the oil completely free of moisture. It is therefore the most effective means ever devised for protecting Diesel engine bearings.

Write for Bulletin DL-1 which gives additional details on Diesel oil purification.

THE DE LAVAL SEPARATOR COMPANY
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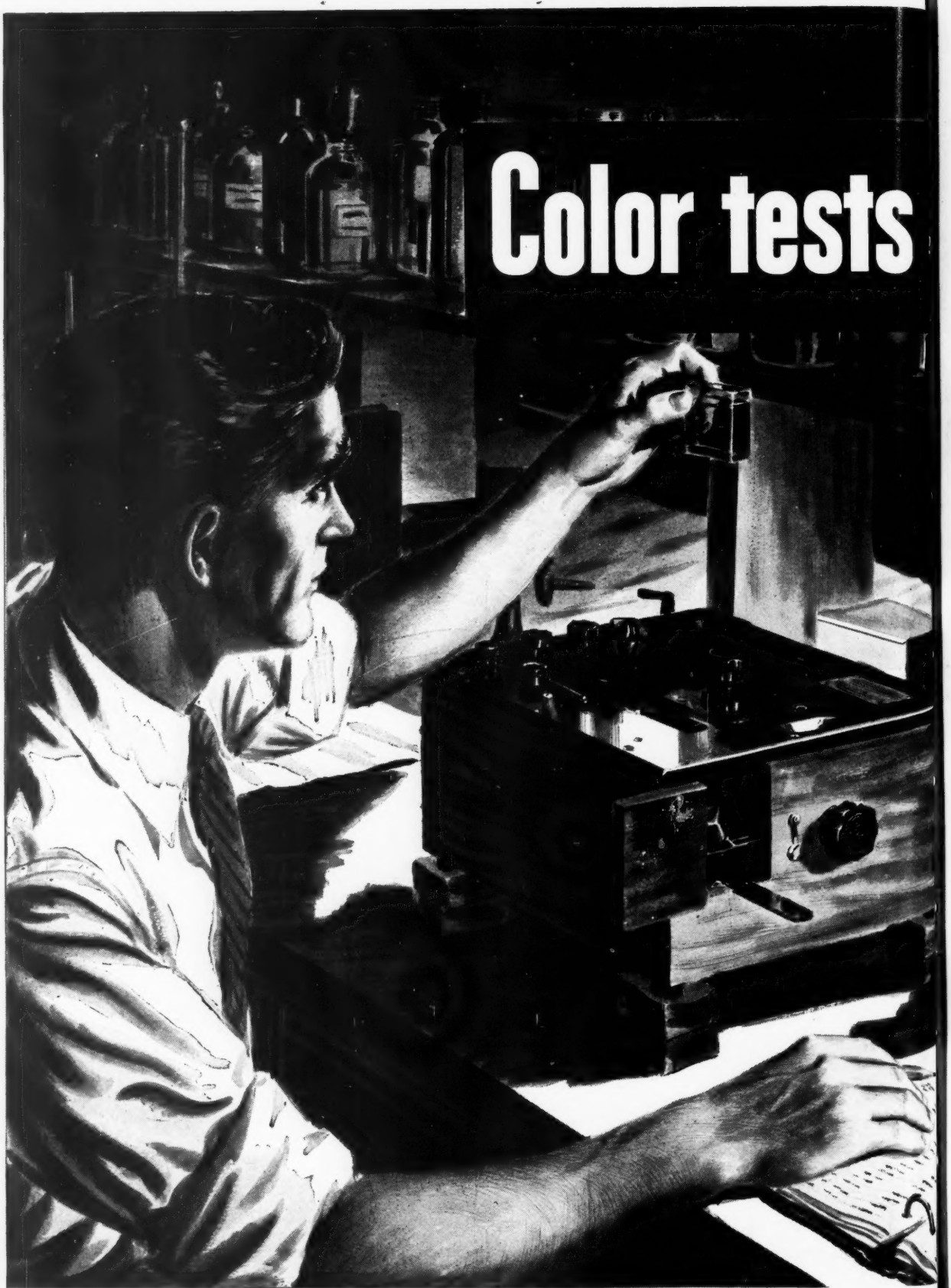
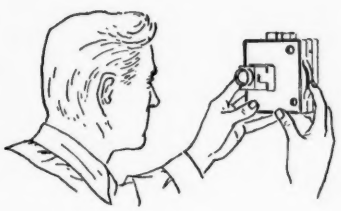
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

DE LAVAL OIL PURIFIERS

FOR DIESEL LUBRICATING OIL


Color tests

mean safer boiler water



Colorimetric methods of chemical analysis are not new, but Hall Laboratories has developed a number of these procedures into a convenient system which permits your own plant personnel to determine quickly and accurately the concentrations of phosphate, silica and nitrate in your boiler water.

Essentially, the colorimetric method involves the addition, to a carefully prepared sample of boiler water, of a chemical reagent which reacts with the substance for which you are testing. This reaction produces a characteristic color in the sample, and the density of the color is an accurate index of the amount of this substance in the sample.

For plant use Hall has adapted a simple optical device,* which permits the operator to match the color of the test sample against permanent glass standards corresponding to known concentrations of the substance for which he is testing. Figures on the disc in which the comparison color standards are mounted give a direct reading of the concentration of the test sample.

With this system any boiler operator can determine in a few minutes if he has phosphate present which will inhibit scale formation, a nitrate concentration which will protect against embrittlement—or a silica content in the recommended range.

In developing the procedures described above, objective research techniques, including measurement of color density by means of photoelectric colorimeters, were employed. This method of measurement is regularly used in Hall Laboratories in the testing of boiler water samples from clients, thus providing a continuing check on the accuracy of field analysis.

Steady improvement of test procedures is one reason why hundreds of plants, of all types and sizes, in all parts of the country, are Hall clients.

**This apparatus and other equipment and supplies required for boiler water analysis are available from Hagan Corporation or Buromin Company.*

HAGAN HALL BUROMIN CALGON

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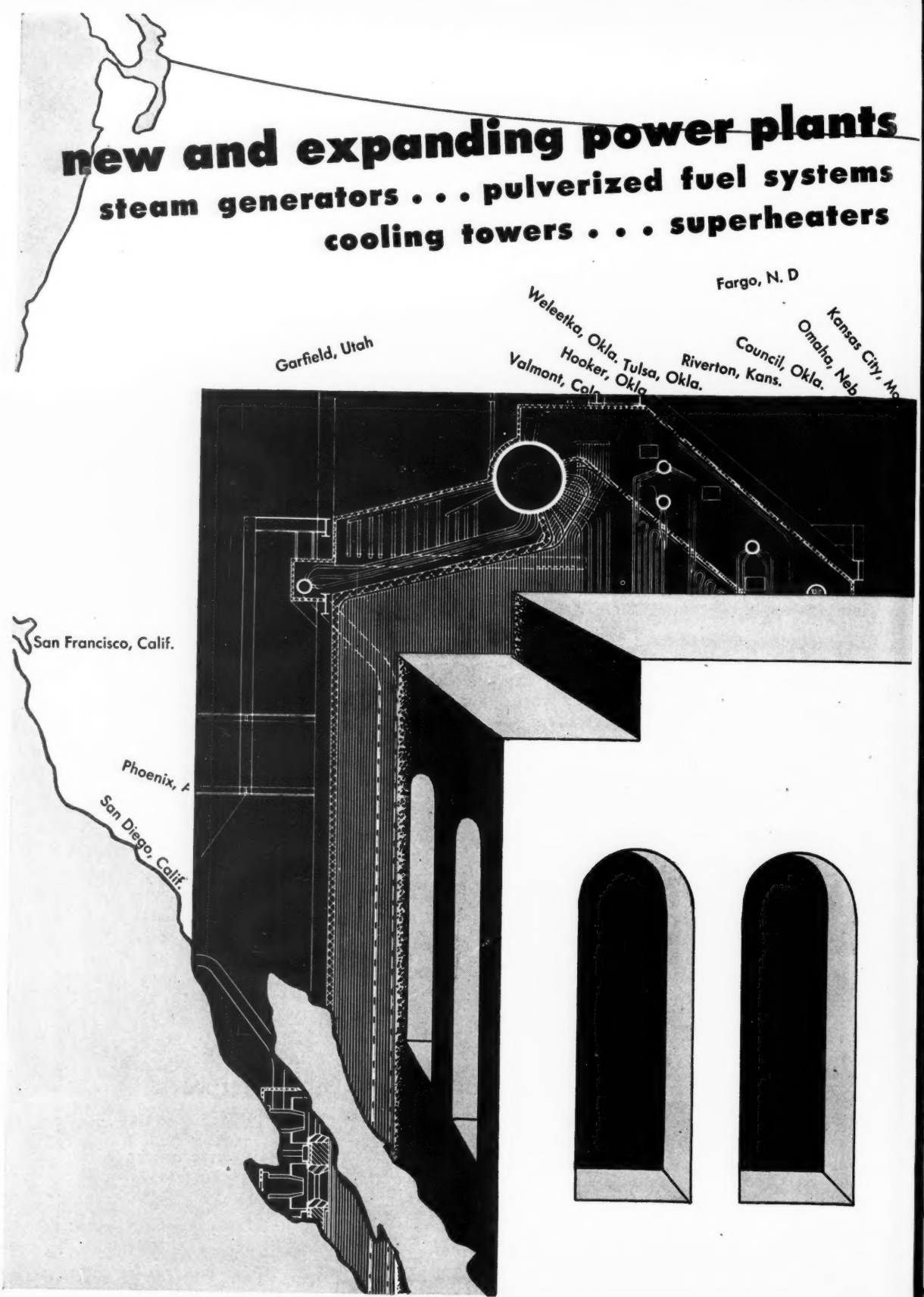

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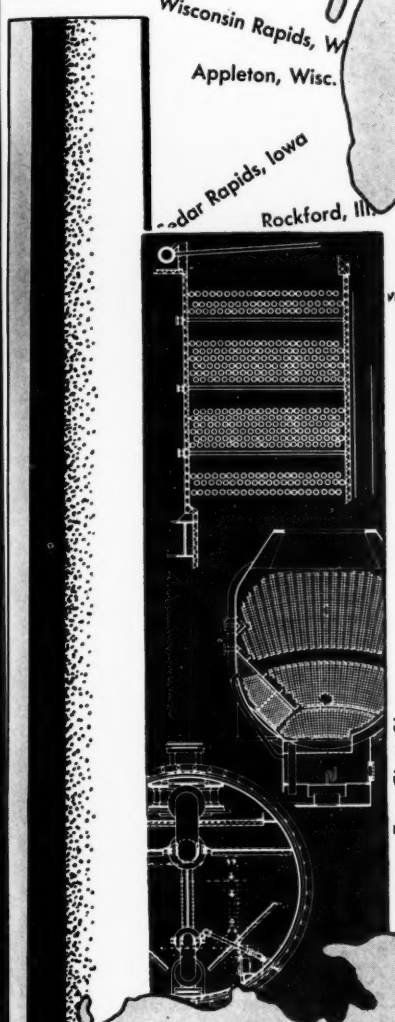

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. . . a book that tackles the Housing Problem in a Businesslike way!

EVERYONE CONCERNED with the seriousness of America's housing problem will want a copy of this book, just off the press.

Here is a straightforward statement of all the issues and factors involved in the housing problem and an equally frank presentation of a definite plan for solving it. It is comprehensive and completely to the point, we believe, and should be of positive value to every individual who has an interest in this subject.

The book includes a summary of all the principal housing proposals advanced by prominent civic leaders. It reviews the steps being taken by various cities for planned community development, and points the way to more widespread planning of this type on a broader scale. Emphasis is placed upon the necessity for adequate utility service planning in such developments and a clear cut case is made for the inclusion of centralized community heating as one of the essential utility services. Attention is also directed to the factors of fuel availability and fuel costs as being among the most important influences in community development planning.

A study of a community development of 15,900 individual homes is another important feature of the book. This section includes a detailed engineering analysis, by a nationally prominent consulting engineer, of the recommended central heating system, comparing its construction and operating costs with the corresponding costs of individual heating plants for each separate dwelling unit.

An informative appendix comprises a resume of some twelve major housing developments sponsored by major life insurance companies and saving banks, with particular attention given to the heating systems of each project.

This book is not a piece of advertising, but a practical reference on the status of mass housing to date, for the use of anyone actively interested in housing developments. If you have bona fide use for it, please write us on your business stationery and we shall be glad to forward you a copy without charge or obligation.

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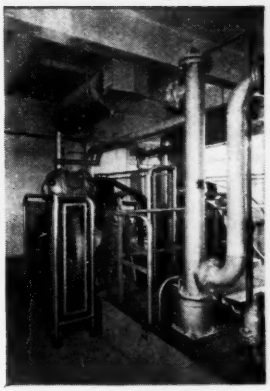
REPRESENTATIVES IN PRINCIPAL CITIES

View of Coty plant at Suresnes, France



Rear view of Worthington Compressors, showing Multi V-Drive aftercooler and receiver.

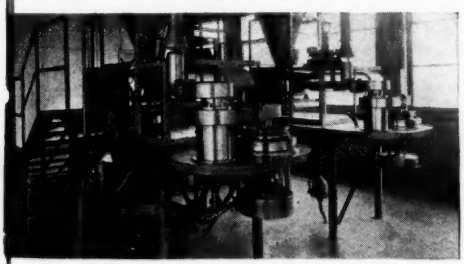
These Machines Put the Air in "Air-Spun" Face Powder

For a number of years, Coty, Inc. (Societé COTY), in its plant at Suresnes, France, has used air-actuated micronizers to provide the high degree of fineness and smoothness that characterizes Coty's "Air-Spun" face powders.

Coty pioneered in this development of supplementing mechanical methods of processing the ingredients with this method which causes the mechanically-processed materials to impinge against each other, effecting extremely minute pulverization.

Carefully metered volumes of compressed air are delivered at 95 psi to the micronizers, where directional air nozzles create intensive and diverse swirls, producing the desired pulverization.

To provide oil- and moisture-free compressed air, Coty selected Worthington compressors, 12 x 11 machines rated at 95 psi, 250 cfm, and 25 rpm, driven by 50 hp, 1200 rpm motors.



Micronizers in Coty plant. Air fed through directional nozzles causes powder particles to impinge against each other, producing minute pulverization. Particle size is controlled by rate of feed.

Special Features

In order to reduce vibration and noise to a minimum, the compressors were specially-built. Aluminum, rather than cast-iron, pistons reduced inertia and resultant unbalanced shaking forces. Placing the motor nearer the crank end of the machine brought the center of gravity into a more favorable location in respect to the foundation.

To prevent the machines from operating in synchronism for any length of time, sheave diameters were modified slightly, giving a compressor speed of 250 rpm for No. 1 unit, 245 rpm for No. 2 unit, and 240 rpm for No. 3 unit. Although two machines could at some time, be in step, synchronism would be instantaneous only. Adjacent compressors on the same center line were installed opposed, as a further compensation for unbalance.

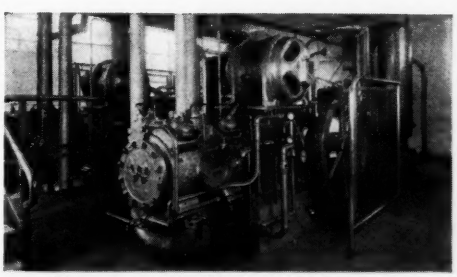
Sensitive Mercoid pressure switches, actuated by air-receiver pressure, are set for slightly different pressures so only those compressors required to meet air demands will operate. No. 1 pressure switch opens at 100 and closes at 95 psi; No. 2 pressure switch opens at 99 and closes at 94 psi; No. 3 pressure switch opens at 98 and closes at 93 psi; and No. 4 pressure switch opens at 97 and closes at 92 psi.

Timing

The timing relay, actuated by a small sub-synchronous motor, provides a delay between the energizing of any two motor starters, preventing second motor from starting until the first is running with the compressor fully loaded.

The four reset pushbuttons serve as cutout switches during weekend and shutdown periods. Also, they prevent the automatic restarting of any unit after it has been automatically shut down from causes such as loss of jacket cooling water or current failure.

Each compressor has its individual aftercooler and air receiver. Aftercoolers, somewhat oversize, provide a longer cooling time to give a maximum of oil and moisture separation. An automatic moisture trap expels oil and moisture separated in the aftercooler. A second trap removes further condensation and separation occurring in the receiver. Twin mechanical oil separators are installed just beyond the air receivers. To prevent discoloration difficulties the inside of the aftercoolers and receivers are galvanized, or covered with rust-proof paint; distribution-system piping and fittings are of brass.



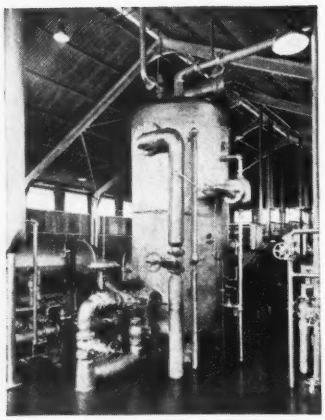
Two 12 x 11 Worthington HB Compressors which furnish air to the micronizers.

NEWS

FROM THE POWER FRONT

AS REPORTED BY THE DEVELOPMENT ENGINEERS FIELD SERVICE REPRESENTATIVES AND CUSTOMERS OF WORTHINGTON

NEWS from the power front

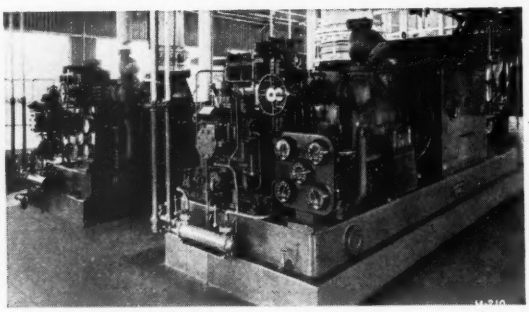


Worthington deaerating feedwater heater—90,000 lb. hr.

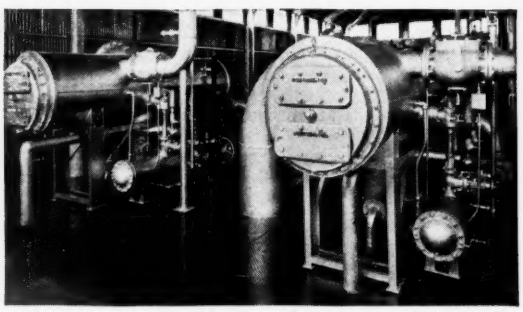
It Takes a Lot of Worthington Equipment to "Dry Out" Gas

These pictures show some of the Worthington equipment installed in The Chicago Corporation's Feazel & Kinsey gasoline plant located at Carthage, Texas, designed and built by Stearns-Roger Manufacturing Co. of Denver.

The purpose of this plant is to take the wet high-pressure gas produced from the high-pressure gas wells in the Panola County fields, and separate the water vapor from the recoverable hydrocarbon vapors consisting primarily of propane, butane, and gasoline. The residue dry gas leaving the absorbers is delivered to the pipe line for transmission and distribution.



Two 750 KW Worthington steam turbine-generator units



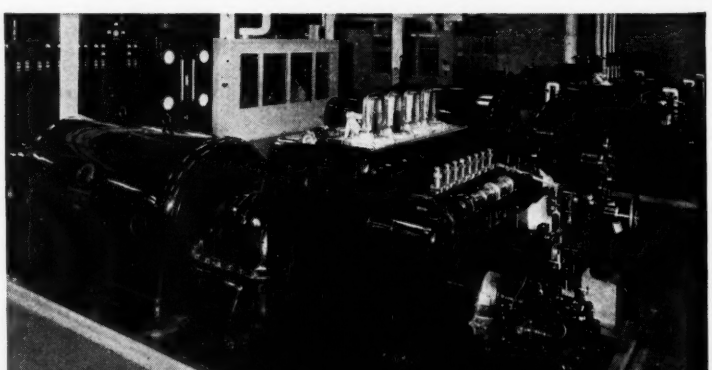
Two 800 sq. ft. Worthington surface steam condensers and condenser accessories

What Makes Willow Run Run?

Electric power for the Kaiser-Frazer plant at Willow Run, Michigan, is furnished by two Worthington 2500 kw Turbine-Generators.

These units are direct-connected, 3600 rpm, 13,800 volt, 3 phase, 60 cycle. They operate on steam at 250 lb initial pressure, 470 F total temperature, exhausted at adjustable pressures of 15-50 lb to a condenser of 27½ in. vacuum.

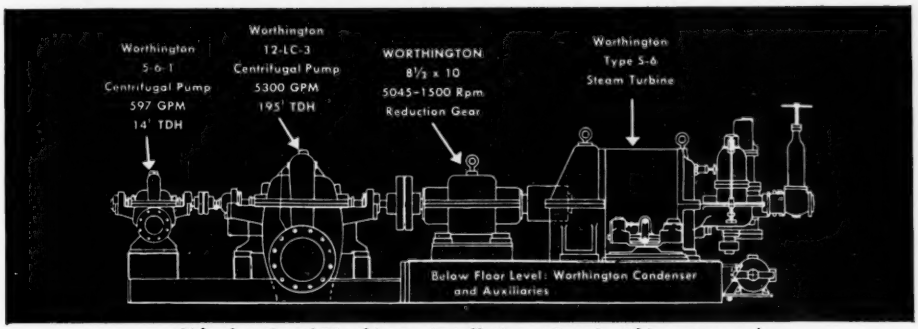
Installed in 1941, these Worthington Turbine-Generators supply both electric power and extracted steam for plant heating.



Worthington 2500 KW Turbine-Generator at Kaiser-Frazer plant, Willow Run

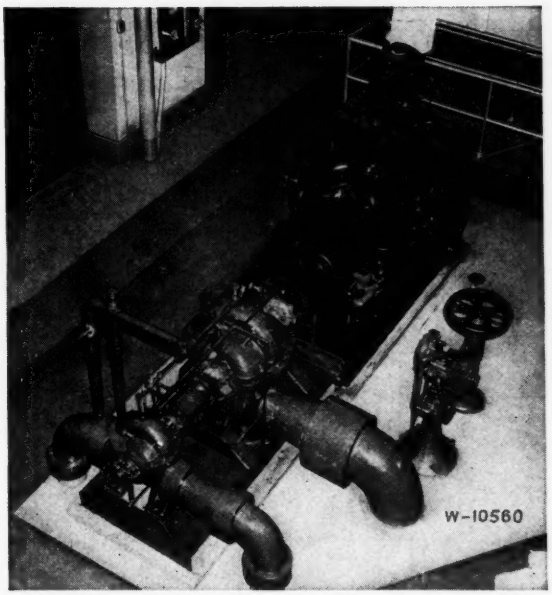
Worthington Pump and Machinery Corporation
Harrison, N. J.

NEWS



Side elevation of Worthington installation at Lorain, Ohio, water works

A Lot of Water Has Gone Through This Pump



Worthington Centrifugal Pump in water works at Lorain, Ohio

More than ten years ago, the city of Lorain, Ohio (a community of 45,000 people) installed a Worthington centrifugal pumping unit to deliver seven and one half million gallons of water per day.

H. B. Wallace, chief engineer of the water works, reported recently that this Worthington pump has operated continuously ever since with never a shutdown except for routine maintenance.

During the majority of the time the pump has handled the entire capacity load; and at various times it has been required to handle appreciable overloads.

The complete water works unit consists of a 7.5 mgd 12 in. pump that is driven by a geared steam turbine with the main pump shaft double extended for connection to the condenser circulating pump; also a surface condenser with its auxiliaries.

All elements are of Worthington manufacture, thus giving undivided responsibility for proper operation.

Springfield Purchases 3rd Worthington Turbine Generator Unit

The city of Springfield, Minnesota, has for a long time operated its own electric power plant.

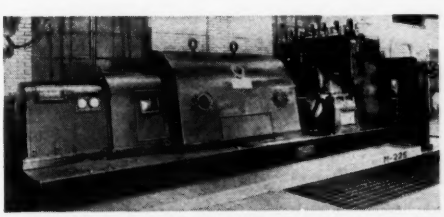
In 1895, electric power was furnished in a limited way from 5 to 10:30 P.M. each day by a 40 kw generator driven by gasoline engine. In 1902 a steam engine with 50 kw belted generator was installed. In 1915 this was replaced by a 100 kw steam engine, and the system was converted from direct current to alternating. At the same time a heating system for the business district was installed, using the exhaust steam which would otherwise be lost to atmosphere.

Further expansion came in 1923 with a 250 kw steam engine. By 1937 the electric load had so far outstripped the heating load that it became necessary to exercise economy in order to reduce cost of operation. A 750 kw Moore automatic bleeder condensing turbine was installed; it was designed for 400 lb steam pressure, 670 F temperature.

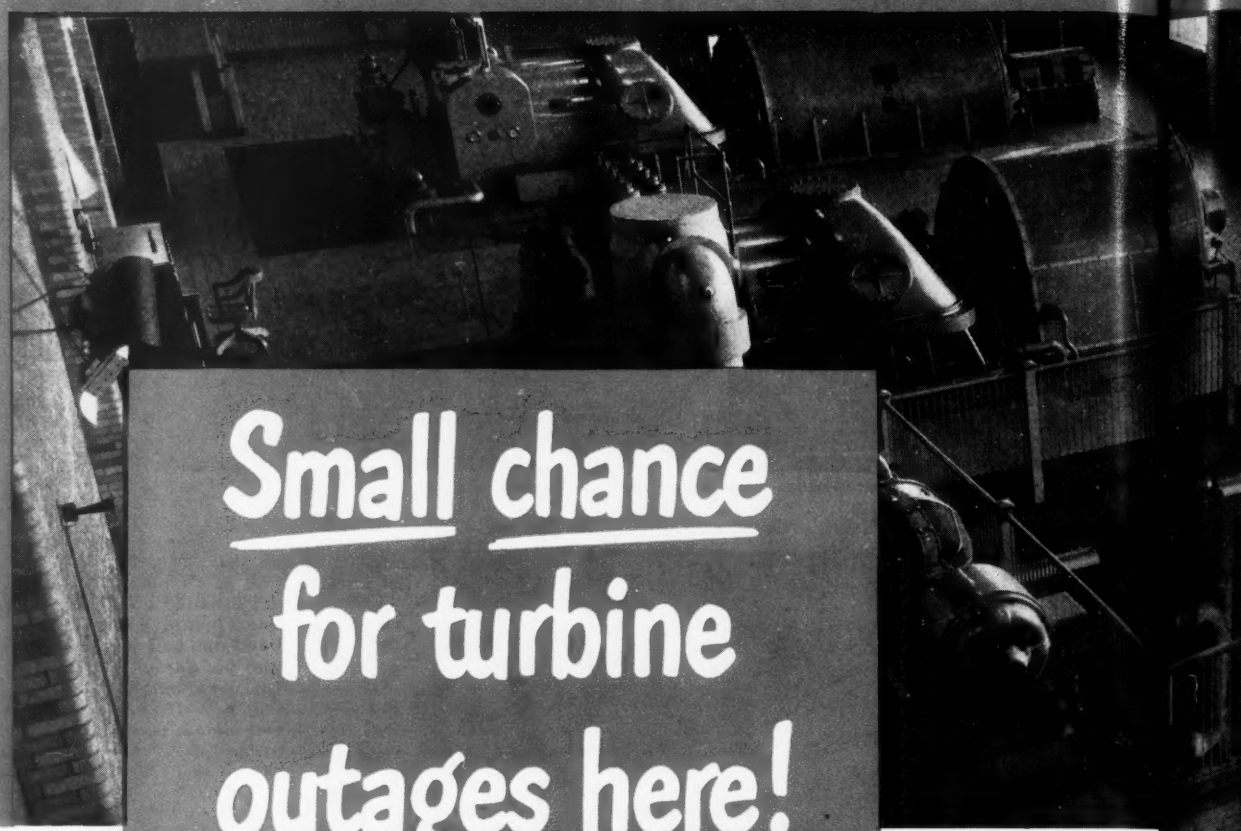
Then the necessity for adapting all the modern practices of steam plants — including higher pressure and temperature–led to the purchase of a 1000 kw Moore automatic bleeder condensing turbine.

Acquisition of REA power contracts necessitated further expansion of the facilities. Last year a 2000 kw Worthington automatic extraction unit was put into operation along with a new high pressure boiler.

The plant now realizes maximum efficiency from the advantages of modern design.



Worthington 2000 kw turbine generator, City of Springfield, Minnesota



Small chance for turbine outages here!

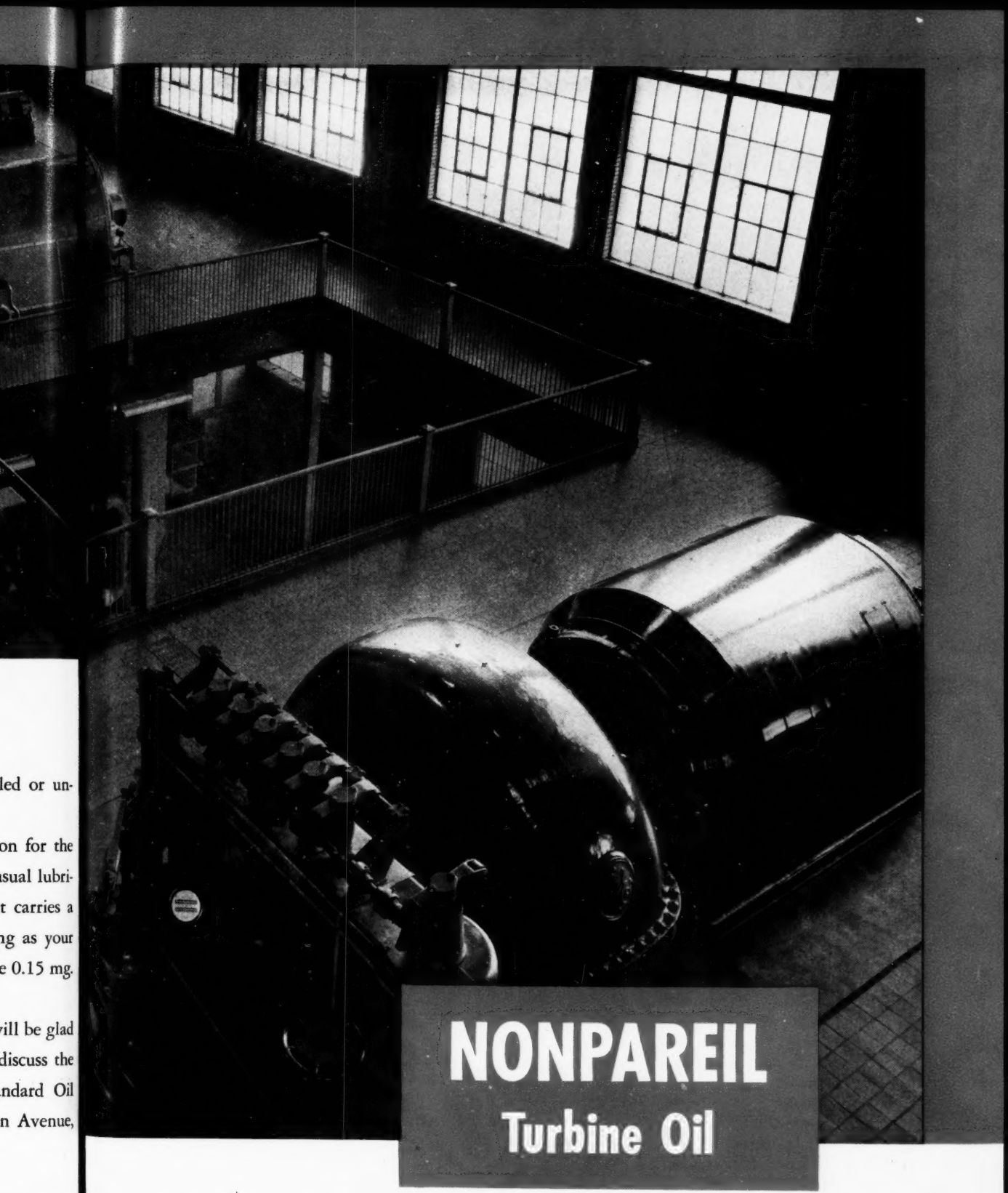
The midwest utility plant, shown in the above photograph, runs little risk of enforced turbine outages because of oil trouble. The 14-year performance record of Nonpareil Turbine Oil at this plant provides the basis for this assurance of safety.

In 1934, Nonpareil was put into one 15,000 KW turbine. A 7,500 KW unit and a second 15,000 KW unit were started on Nonpareil in 1935 and 1941, respectively. The original fills of oil have remained in these turbines for the 7 to 14 years of operation. There has been no deterioration of the lubricant. The oil has not been removed for treating or resting, yet neutralization numbers have stayed below 0.09. There has been no outage time, scheduled or unscheduled, for oil-system maintenance.

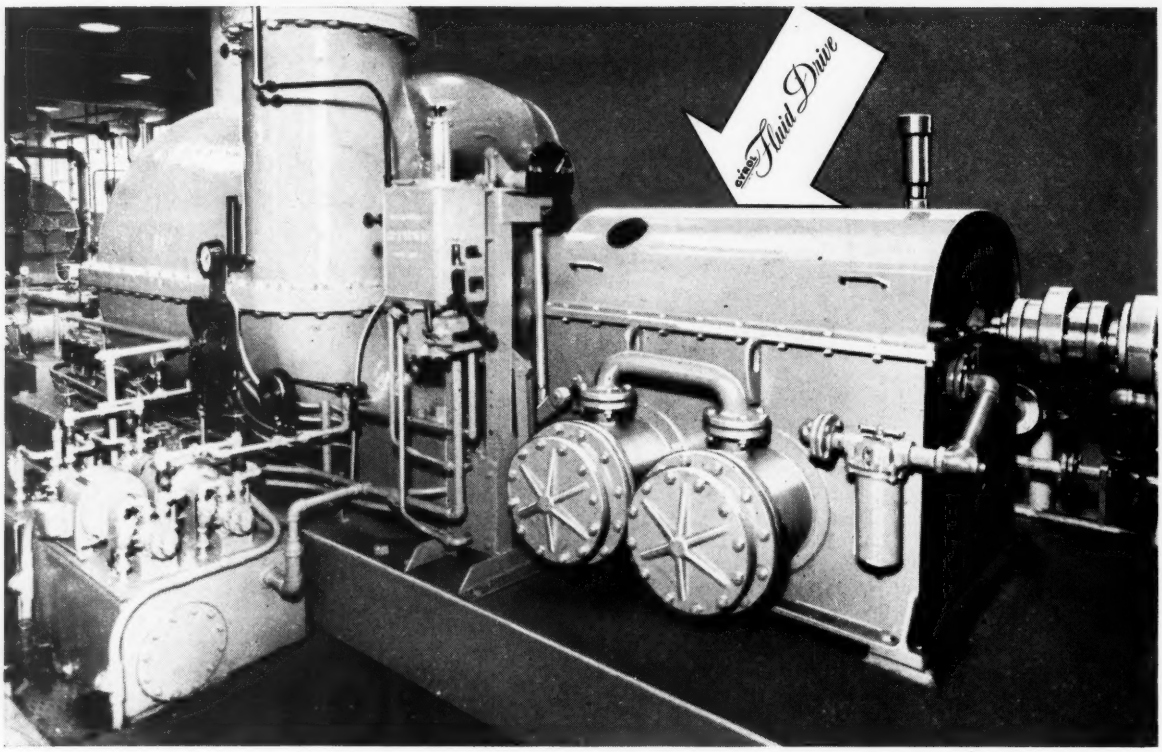
Nonpareil assures trouble-free operation for the life of *every* turbine it lubricates. This unusual lubricant is the only product in its field that carries a written guarantee that it will last as long as your turbine without increasing in acidity above 0.15 mg. KOH/gm.

A Standard Oil Lubrication Engineer will be glad to show you this written guarantee and discuss the advantages it holds for you. Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY (INDIANA

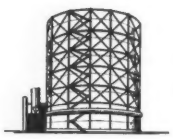


IANA STANDARD OIL COMPANY (INDIANA) STANDARD



Type VS, Class 6 Gýrol Fluid Drive attached to gas supply booster.

Gýrol Fluid Drive saves power and protects machinery in gas industry



Maintaining the supply in a gas reservoir is a difficult job.

Gas consumption varies. Yet the pressure inside the reservoir must always remain constant. The gas supply booster, which refills the reservoir, must consequently vary the input to meet these fluctuations.

Here's where Gýrol Fluid Drive comes in.

Attached to the gas supply booster, Gýrol Fluid Drive provides stepless speed control that can be easily and accurately adjusted to keep the pressure up.

The Fluid Drive also allows no-load starting for the 1500 h.p. motor.

The advantages? Substantial savings in power, longer machine life and quieter operation. Power transmission with Gýrol Fluid Drive is completely foolproof, dependable and easy to operate.

Your business

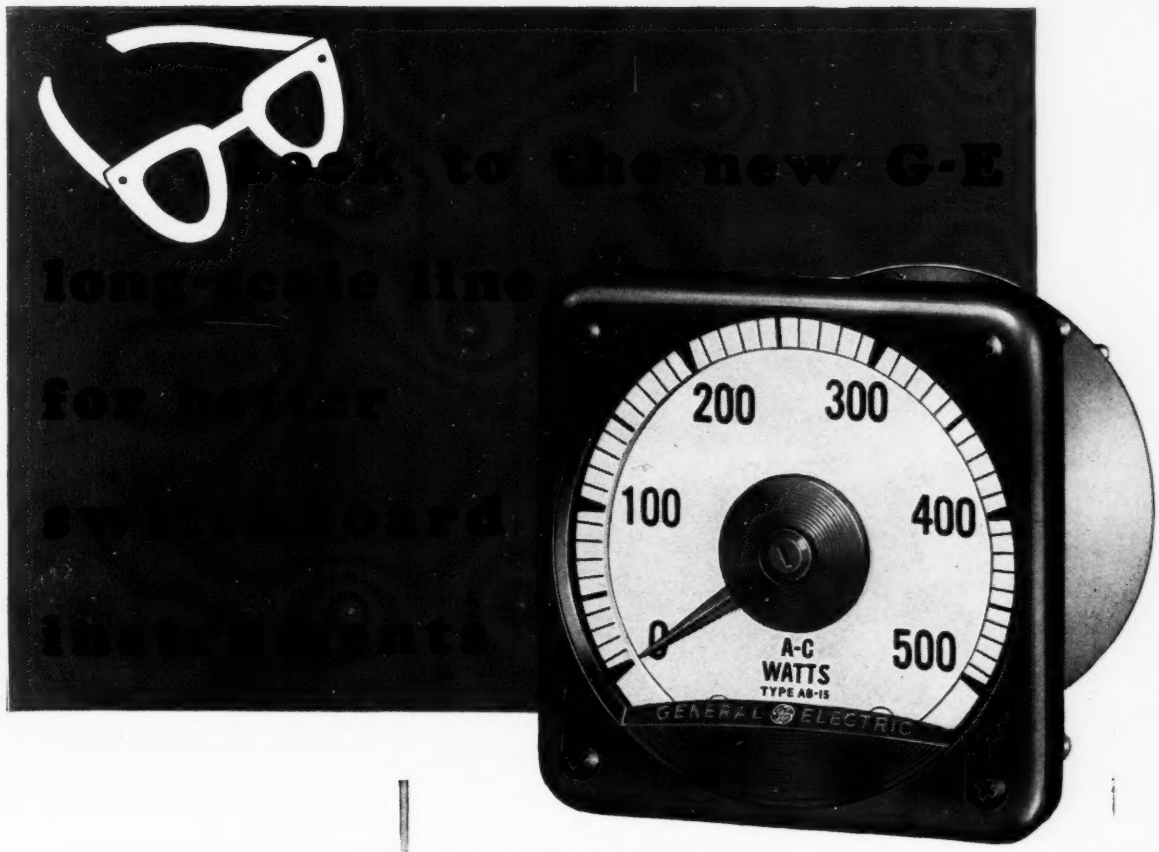
If you're concerned about power transmission in any plant or on products, or, if you want to improve the over-all efficiency of existing processes, investigate the unique advantages of Gýrol Fluid Drive.

Write today for information on Gýrol Fluid Drive or consult your nearest American Blower Branch Office. There is no obligation.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary corporation

AMERICAN BLOWER
GÝROL *Fluid Drive*

Serving home and industry
AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS • DETROIT LUBRICATOR • KEWANEE BOILER • ROSS HEATER • TONAWANDA IRON



MODERN APPEARANCE, BETTER READABILITY, AND ADVANCED MECHANICAL DESIGN HIGHLIGHT THE NEW G-E LONG-SCALE LINE OF SWITCHBOARD INSTRUMENTS. SEE HOW THESE FEATURES LEND INCREASED ATTRACTIVENESS AND OPERATING EFFICIENCY TO YOUR SWITCHBOARD.

Why settle for less when you can get all these features coupled with the many other refinements found in all G-E Instruments? Insist on the G-E long-scale line, and be sure of the best. Ask your nearest G-E sales office for further information on these AB-15 (a-c) and DB-15 (d-c) switchboard instruments . . . .

A-C Ammeter
A-C Wattmeter
A-C Voltmeter
D-C Voltmeter
D-C Ammeter
Frequency Meter
Power-factor meter
Temperature Indicator
Synchroscope

QUICKER, MORE ACCURATE READING—Long (7.1 inch) scale spans 250 degrees, with all numerals upright. Circular mask covers mechanism at center of dial, emphasizing scale and pointer.

MODERN, STREAMLINED APPEARANCE—Attractively styled black Textolite case, designed for semiflush mounting.

STURDINESS—Spring-mounted jewels provide maximum protection for pivots.

EASE AND ECONOMY OF SERVICING—Assured by new unit design. Entire moving mechanism can be removed without disturbing calibration.

OTHER IMPROVEMENTS ARE—

Added compactness from self-contained potential resistance in transformer-rated instruments.

Space saved. Small size—only 4¼ inches square—permits mounting five instruments side by side on a panel only 24 inches wide.

One-per-cent accuracy. Antiparallax scale and pointer plus antiglare glass permit readings from any angle.

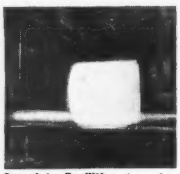
Bulletin GEC-218 gives more details. Apparatus Department, General Electric, Schenectady 5, N. Y.

GENERAL ELECTRIC

660-127

Metallurgical Research conducted continually by recognized specialists who have made major contributions in this field.

Unique Technical Backing of an extensive organization with an international reputation in both process and fabrication engineering.

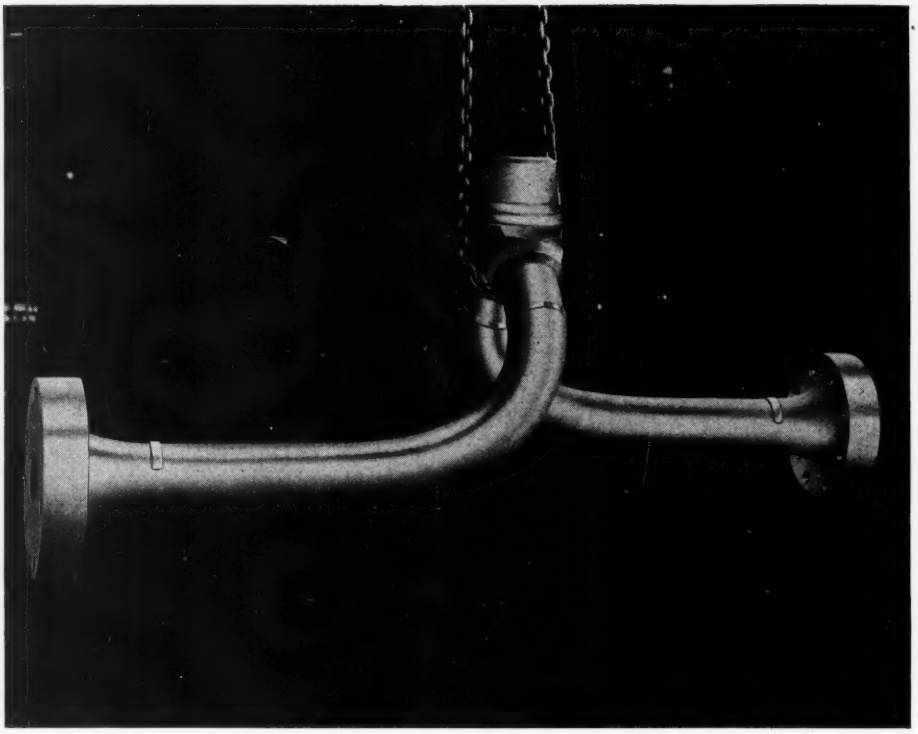


Complete Facilities for the fabrication of steel products from simple forgings to the most intricate 120 foot towers.

Quality Control embracing the constant application of the most advanced inspection methods, both visual and non-destructive.

On-Time Delivery made possible by a flexible planning group authorized to re-route work to meet promised dates.

Top Welding Performance assured by specially designed equipment and exclusive employment of master operators.



Up-to-the-minute . . . because 30 years are behind it

300,000 KW of new electrical power capacity depend on this and companion pieces of piping—destined to connect the throttles and steam chests of three new turbines in a large metropolitan powerhouse. They are made of 18-8 alloy steel—.718" thick, 6⅝" outside diameter, to operate at 1730 psig at 1050°F. There just can't be any defects, any locked-up stresses, any faulty metal formations, or deviations from contour, no matter how minor—not in piping as important as *this*.

Kellogg started preparing for this order more than thirty years ago . . . when a turbine was a textbook subject and 18-8 was just out of the laboratory. It was then that Kellogg started to amass alloy performance data . . . started to investigate methods of welding and heat treatment . . . established the nucleus of the present Kellogg Metallurgical Laboratory and Quality Control System.

The data, the amassed knowledge, the fabricating experience of thirty years are as apparent in the perfection of these vital power connections for industry as they are in the pioneering work which Kellogg metallurgists are now undertaking in the newer and more dramatic fields of gas turbine, rocket and ram jet propulsion devices.

When you place orders today with Kellogg for critical power piping you know that each piece of piping delivered, bearing the Kellogg stamp, will have this same thirty years of preparation behind it.

FABRICATED PRODUCTS DIVISION

THE M. W. KELLOGG COMPANY

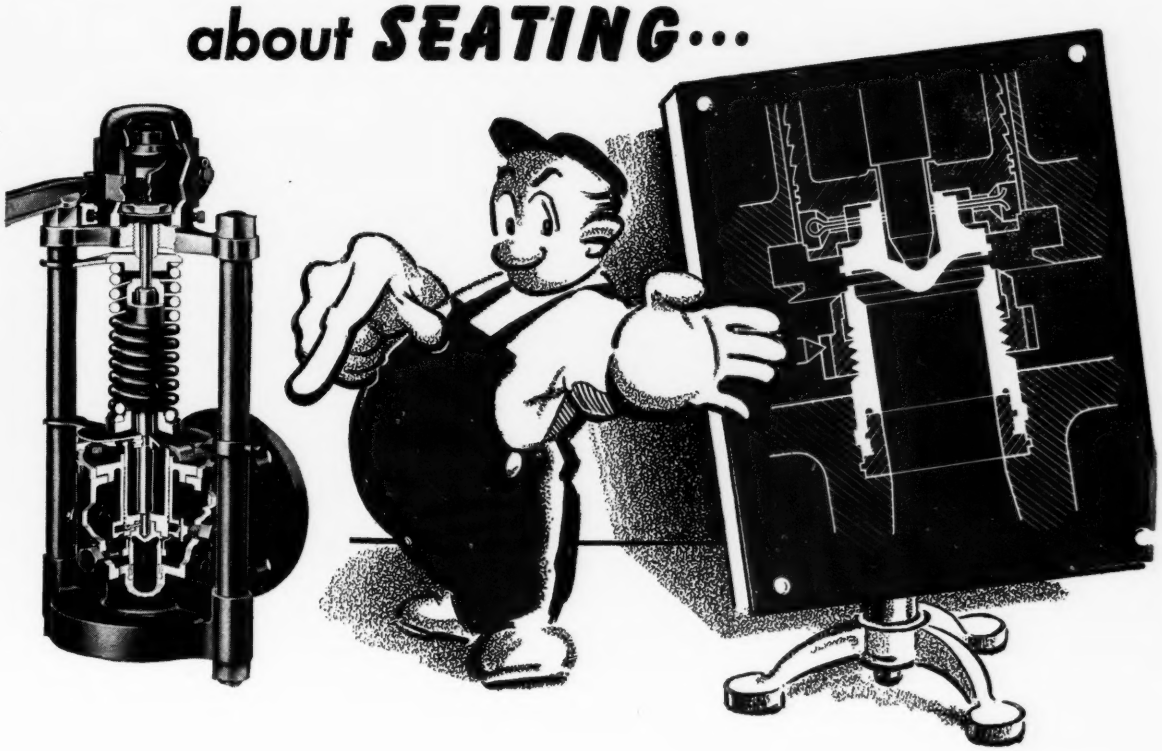
A SUBSIDIARY OF PULLMAN INC.

NEW YORK • JERSEY CITY • BUFFALO • LOS ANGELES
TULSA • HOUSTON • TORONTO • LONDON • PARIS

VESSELS • EXCHANGERS • CONDENSERS • HIGH PRESSURE AND HIGH TEMPERATURE POWER PIPING
PROCESS PIPING • FORGED AND WELDED FITTINGS . . . IN ALL STEELS, ALLOYS OR SPECIAL COMBINATIONS

We Studied SAFETY VALVE LEAKAGE

— Here's what we found out about SEATING...



We found—what most power plant men already know...that in order to be tight, a safety valve must have matched, wear resistant, corrosion resistant seating surfaces, and that the disc must seat square.

We found—what power plant men have long suspected...that uneven expansion, causing dragging of one seating surface over the other, can destroy the seat so completely that the safety valve has to be overhauled or replaced, even though it has never been popped.

We found...that when nozzle and disc are made of alloys with the same coefficient of expansion, and with sections designed so that their rate of heat absorption is the same, destructive drag is eliminated. That is the reason Foster 38-8V Safety Valves can be guaranteed to stay tight.

To you...this means elimination of costly boiler outage due to safety valve leakage. Other guaranteed advantages are...consistently accurate popping...minimum blow-down, which can be held to as little as 1%... highest relief capacity for a given nominal valve size... and extremely low maintenance.

For full details on the design and construction features that enable this valve to outperform any other safety valve, get in touch with your Foster Representative or with us direct.

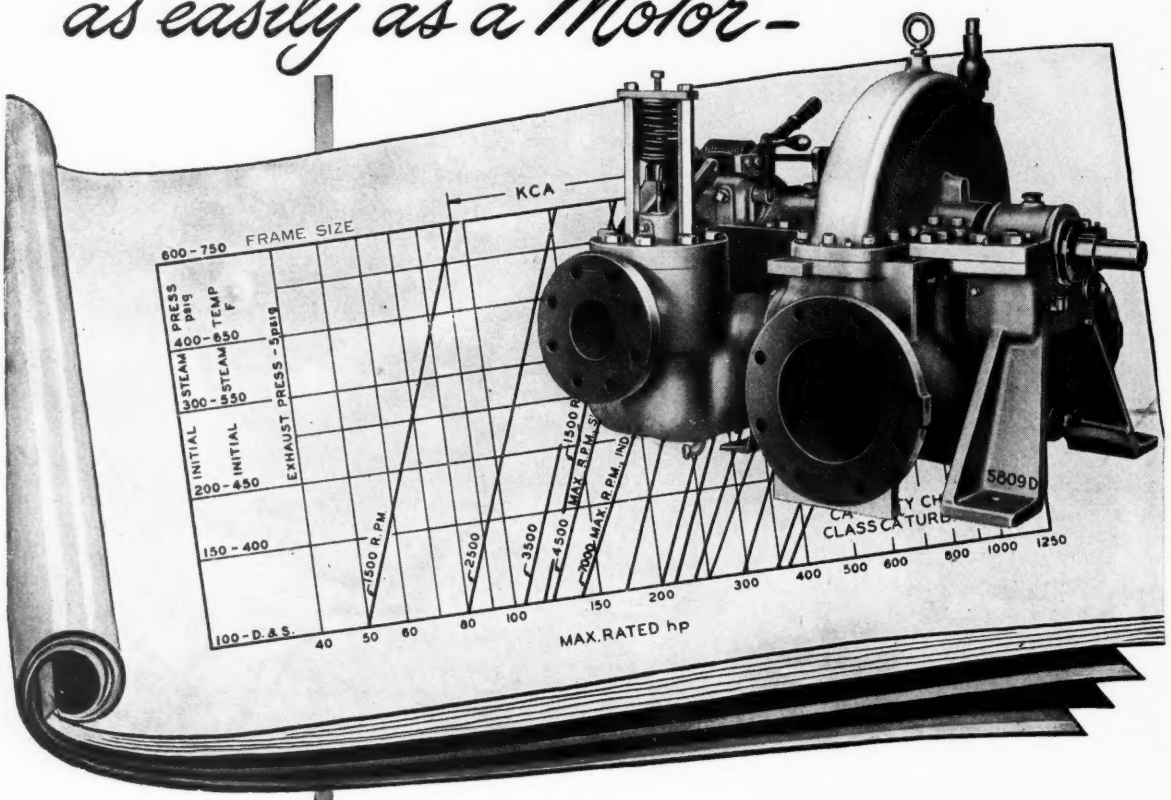
FOSTER ENGINEERING Company

PRESSURE REGULATORS...RELIEF AND BACK PRESSURE VALVES...AUTOMATIC STOP AND CHECK VALVES...ALTITUDE VALVES...DAMPER REGULATORS...FAN ENGINE REGULATORS... PUMP GOVERNORS...TEMPERATURE REGULATORS...LIQUID LEVEL CONTROLLERS...FLOAT AND LEVER BALANCED VALVES...NON-RETURN AND TRIPLE DUTY VALVES...VACUUM REGULATORS OR BREAKERS...SIGHT FLOW BOXES...STRAINERS...SAFETY VALVES...SIRENS

111 MONROE STREET • NEWARK 1, N. J.

Now YOU CAN SELECT A TURBINE

as easily as a Motor–



SIMPLIFIED RATINGS FACILITATE SELECTION OF NEW DE LAVAL MECHANICAL DRIVE TURBINES

Because of the great demand for the reliability, speed variability and economy inherent in mechanical drive steam turbines, the De Laval Steam Turbine Co. has designed a new standardized line of velocity stage turbines, manufactured these units in quantity for prompt delivery, and published simplified rating tables that make the preliminary selection of the right turbine size as easy as the selection of an electric motor.

Send for catalog describing the new and improved De Laval Class CA velocity stage steam turbine for mechanical drives.

DE LAVAL

DE LAVAL STEAM TURBINE CO., TRENTON 2, NEW JERSEY

Atlanta • Philadelphia • Los Angeles • Chicago • Pittsburgh • San Francisco • St. Paul • Cleveland • Tulsa
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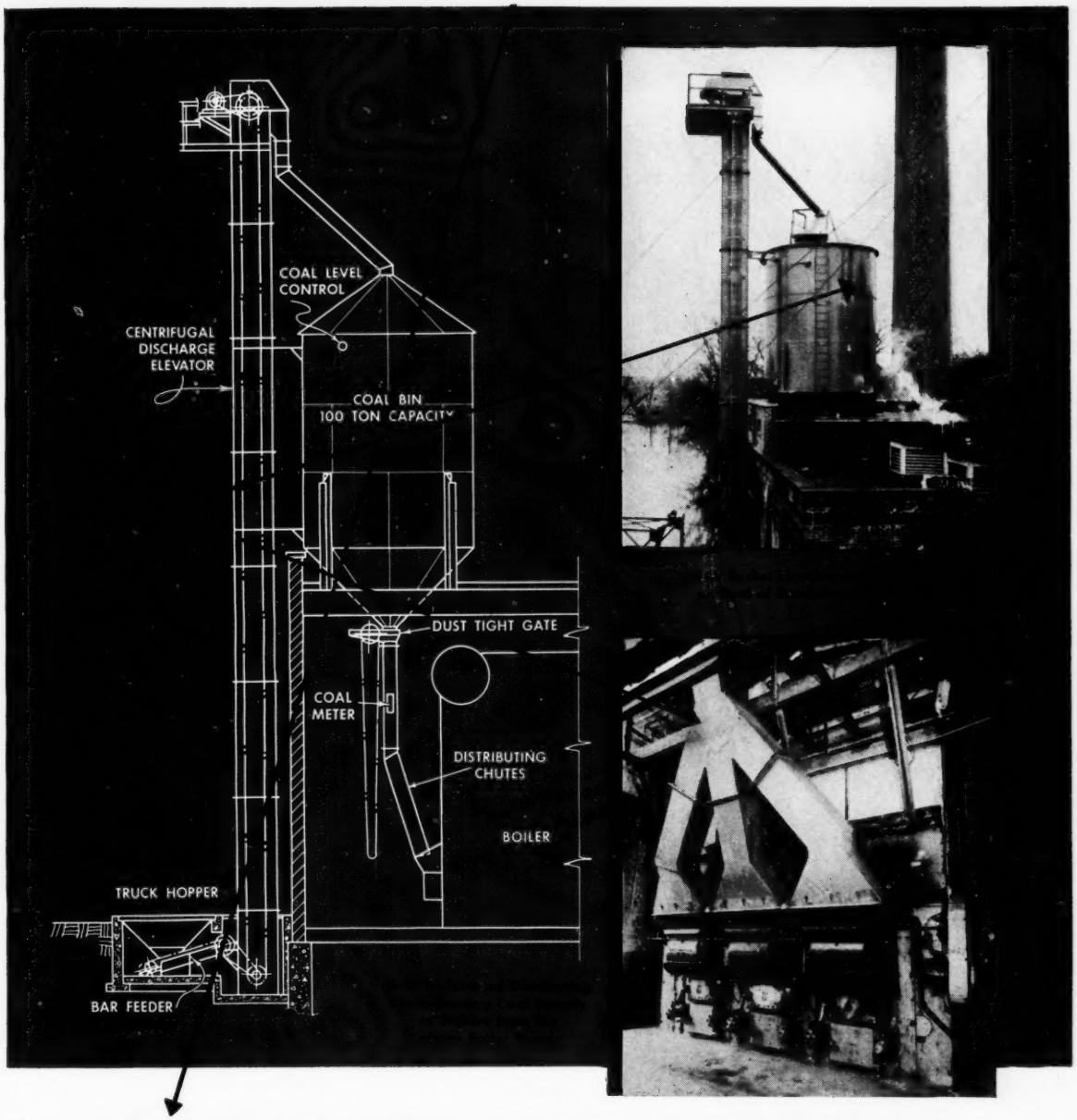
New Orleans • Edmonton • Denver • Salt Lake City • Winnipeg • Helena • Houston • Washington, D.C.

T-13

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS



IN THIS CASE tight quarters saved dollars

When Braendly Dye Works, Inc., at Beacon, N. Y., modernized their steam boiler plant, a mechanical coal-handling system was required to replace the old, slow manual method. A G-W engineer was called in... recommended the elevator-storage system illustrated.

A river bank restricted ground storage space... a disadvantage that G-W ingenuity converted into economies. A live storage, steel bin was designed and mounted on roof directly over boiler room. Coal is supplied to bin by a bucket elevator and fed continuously by gravity directly to stokers. Warm boiler room air surrounds bottom cone of bin...prevents coal freezing.

Elevator boot is fed by bar type feeder which permits a truck hopper shallow enough to safeguard against flooding when river is high.

G-W took over *this* complete job... from design through construction and erection... shouldered all responsibilities. G-W's complete engineering service is yours for the asking.

G-W HANDLES IT...
faster • easier • cheaper

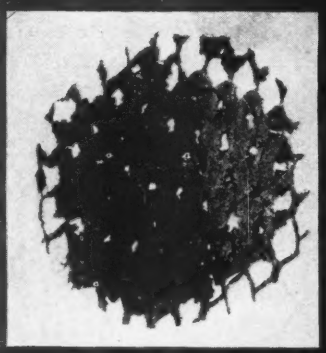
GIFFORD-WOOD CO.

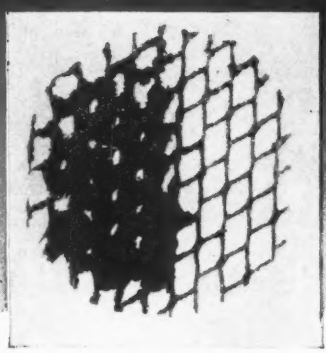
4208

SINCE 1814 | NEW YORK 17, 420 LEXINGTON AVENUE | Factory: Hudson, N. Y. | CHICAGO 6, 565 W. WASHINGTON ST.

announcing. Nalco SR-150

THE SOOT REMOVER THAT REMOVES SOOT!





Same screen as above after temperature rise to 775° F—the treated soot has burned off; untreated coal soot usually burns at about 1135° F.

For the first time, a *scientifically-developed* soot remover that REMOVES SOOT! Nalco SR-150 is the result of years of research, development, and thorough plant tests by Nalco scientists and an independent research organization. Nalco SR 150 removes soot from boiler surfaces by lowering its ignition temperature so that it burns off at normal furnace operating temperatures.

Soot removal with Nalco SR-150 is accomplished with the furnace operating as usual—no need to provide special firing conditions or take boilers off the line. For large furnaces, Nalco has developed an efficient SR-150 feeder—so simple it can be built in most plant maintenance shops. For small furnaces, SR-150 can be fed directly with the fuel, either hand or stoker fired.

Next best news to Nalco SR-150's guaranteed soot removal ability is a price so low that any other method of keeping heat transfer surfaces clean and flues clear is an extravagance by comparison.

Call your Nalco Representative today, or write direct for complete data and prices on Nalco SR-150 . . . the soot remover that REMOVES SOOT!

DEVELOPMENT REPORT AVAILABLE

The story of Nalco SR-150 development, abstracted from progress reports by an independent research organization. Gives the true facts on chemical soot removal . . . its past failures and partial successes . . . and the reasons why SR-150 has earned a place with other Nalco Quality Products. Your copy sent without obligation on request to Nalco.

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HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

BOILERS, ACCESSORIES

1 **Floating Boiler Walls**—Bulletin 748, 4 pages, describes with numerous sketches the construction and application of air tight refractory enclosures for water walled boilers. Explanation is presented in question and answer form. Geo. P. Reintjes Co.

2 **Boiler Water Level Control**—Bulletin No. 485, 8 pages, describes the boiler water level control at a particular plant. Shown are the steam generator in sectional view, and many close-up shots of the controls as installed. Different controls made by the firm are given on back cover. Northern Equipment Co.

3 **Industrial Stokers**—This four page bulletin describes briefly the ram and worm feed type stokers made by this firm for industrial use. Photos, and coal and gas flow drawings in color, show construction features and operation. Ratings are listed. Canton Stoker Corp.

4 **Water Tube Power Boilers**—This 8 page bulletin describes and illustrates the Type CR boilers. Numerous gas and water flow drawings and close-ups of construction details are given. International Boiler Works Co.

5 **Sectional Steel Boilers**—A four page bulletin describing the boilers made by this firm which may be installed without removing any part of building. These are small boilers for up to 100 psi and 289 hp. Central States Steel Boiler Co.

6 **Scotch Boilers**—Series 4000, 4 pp., describes and illustrates with installation photos the scotch boilers offered. Dimensional drawing and table with data is provided. Construction details explained. Johnston Brothers, Inc.

7 **All Welded Boilers**—Bulletin No. 120, 4 pp., describes ten sizes of 15 through 80 hp welded 150 wsp boilers. Dimensions and data are given for each in a table. Union Iron Works.

ELECTRICAL

8 **Large Induction Motors** — Bulletin 05B6132A, Charts electrical characteristics, power factors, and range of starting torques of motors larger than 200 hp. A motor selection chart show ranges. Allis-Chalmers Mfg. Co.

9 **Fabricated Steel Synchronous Generator**—Bulletin PB 2000, 4 pages, contains 15 detailed views which explain construction features. Mechanical modifications are also included. Elliott Co.

10 **Small Switches**—Data Sheet No. 46, describes the two low torque switches. Characteristics and dimensions are given as well as prices. Also gives instructions on assembling and adjusting torque. Soldering cautions are presented. Micro Switch.

11 **A C Solenoid Contactors**—Bulletin 4452 and 4453, 4 pp., describes features, application, construction, accessibility, main contacts, coils, auxiliary contacts, push button stations, and optional features. Dimensional drawings are given for each of these two contactors. Ward Leonard Electric Co.

12 **Multiple-Circuit Battery Chargers**—Bulletin 222, 4 pp., utilizes exploded views, line drawings, complete assembly photos, and detailed explanation of equipment to explain these chargers. Electric Products Co.

13 **Industrial Electric Motors**—Bulletin MB-1 6 pp., contains cutaway and phantom views which depict the construction and special features of these motors for industrial applications. Also shown and described is the motor driven multi-speed gearshift. Lima Electric Motor Co.

14 **Selenium Battery Charger**—A four page bulletin describing the Edison-nickel-iron-alkaline automatic battery charger, selenium, full wave, 80 per cent efficiency. General specifications are given for 7 models. Richardson-Allen Corp.

15 **Ball Bearing Electric Motor**—Form No. 1904, 6 pp., describes and illustrates the ball bearing electric motors of four different windings made by this firm. Robbins & Myers, Inc.

16 **Waterproof Pulley Lagging**—This 6 pp. folder illustrates the steps necessary for application of the product. Directions are also included. Condersite Engineering Corp.

17 **Differential Speed Reducer**—This four page bulletin describes the speed reducer with helical gears. Six sizes are shown with specifications. Photos and exploded views illustrate the features, construction, and assembly. Winfield H. Smith Corp.

18 **Drive Chains**—Catalog 808, 60 pp., describes and illustrates with numerous photos of applications the use of these drive chains in industry. Detailed explanation is given of construction. A drive chain index is provided, as are hp ratings, and handy engineering data for applying drive chains. Each type of chain and sprocket wheels are described completely. Jeffrey Mfg. Co.

19 **Boiler Feed Pump Fluid Drives**—This 4 page bulletin describes the use of fluid drives for controlling the speed of boiler feed pumps. Photos, a cross-section, and a pump performance chart are given. American Blower Corp.

20 **Variable Speed Transmissions**—Bulletin 67110, 8 pp., describes and illustrates with photos, dimensional drawings and tables, the various models of these small variable speed transmissions. Oilgear Co.

21 **Manganese Bronze Chains**—Bulletin No. 204, 4 pages, presents the detachable type and pintle type chain with tables of engineering specifications and list price per foot. Chains are intended for general conveying use and power transmission applications. Valley Foundry & Machine Works, Inc.

22 **Variable Speed Motor Drive**—Form 1515, 16 pp., uses color to depict the construction and application of these variable speed motor drives. Drives use V-belts. Also depicted are the remote controls available, as is the wide choice of types. U. S. Electrical Motors, Inc.

23 **Cast Iron Pulleys**—Catalog No. 60, 10 pages, contains new list prices and a description of the various types of pulleys which can be produced. Solid catalog of information on these pulleys. Pyott Foundry & Machine Co.

INSTRUMENTS, CONTROLS

24 **Chemical Feeders**—Bulletin INS 2B, 16 pp., is a technical bulletin on the installation, operation and maintenance of this firm's automatic and proportional chemical feeder. It contains detailed instructions on each phase of use. Proportioneers, Inc.

25 **Capacity Data for Orifice-type Meters**—Bulletin T-100-M, 12 pp., explains this firm's method of reaching, within certain limits, the determination of given line size, meter differential, and fluid quantity by the use of a simple basic formula and reference to a simple graph. Book is all engineering data. Hagan Corp.

26 **Liquid Level Recorder**—Bulletin WG-1830, 8 pp., describes and illustrates the improvements that have been made in these recorders. Mounting dimension drawings, phantom views, hook-up diagrams, and installation photos are used to further show improvements. Yarnall-Waring Co.

27 **Megohmer Insulation Tester**—Bulletin No. 450, 4 pages, illustrates the use, gives scale facsimile, and shows small size. All the features of the instrument are described. Herman H. Sticht Co., Inc.

28 **Carbon Monoxide Tester** — Bulletin No. BY-1, 2 pp., describes and tells how to operate this colorimetric CO tester. A table is given to show the effects of CO for a given time on human beings. Mine Safety Appliances Co.

29 **Flow Rate Kit**—Bulletin No. 5, catalog sheet, gives a capacity chart, dimensions, and general illustrations of this flow rate kit for laboratory and pilot plant. Brooks Rotameter Co.

30 **Pyrometer Controller** — Bulletin No. PB1237, 6 pp., describes the application of this new instrument in proportioning the current input to electrically heated devices. Connection drawings and typical charts are given. Bristol Co.

31 **Instrument Panels and Cubicles**—Bulletin 125, 12 pp., is all technical data on designing cubicles and panels for instruments and controls. Numerous drawings, photos, and sketches with dimensions illustrate the applications which these enclosures find in industry. Falstrom Co.

32 **Remote Hydraulic Controls**—Bulletin 2001, 8 pp., illustrates and explains the many applications which these controls find in industry. Sectional drawings show construction. Sperry Products, Inc.

33 **Electric Hand Tachometers**—Bulletin No. 103, 4 pages, describes and explains the electric hand tachometers and accessories for speed measurements. Ranges, prices, and typical applications are shown. Metron Instrument Co.

34 **Leak Detector**—This bulletin sheet describes and explains the applications to which this electronic leak detector is suitable. General specifications are given. Consolidated Engineering Corp.

PUMPS, COMPRESSORS

35 **Portable Air Compressor**—Form 145, 8 pp, describes and illustrates with phantom and cutaway views and many application photos the small portable compressor mounted on a 2-wheeled trailer for towing behind a car. Also shown are the air tools made by the firm. Ingersoll-Rand.

36 **Condensate Return System**—Bulletin No. 3250-1, 4 pp., contains a large dimensional drawing with a table for sizes and dimensions. Unit specifications are given as is a unit selection chart. Cochrane Corp.

October, 1948

POWER GENERATION
53 W. Jackson Blvd.
Chicago 4, Illinois

Please have the manufacturers send me without obligation the literature indicated by the following paragraph number:

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Please Print Clearly

Your Name.....

Your Title.....

Your Company Name.....

Company Address.....

City.....State.....

(If you prefer delivery at your home also fill in below)

Home Address.....

City.....State.....

37 **Heavy Engine Compressor and Pump Products**—This 8 pp., bulletin describes briefly but comprehensively the complete line of products made by this firm. Types, sizes, drives, fuels, speeds, design and construction information is given. The Cooper-Bessemer Corp.

38 **Centrifugal Turret Pumps**—Bulletin 1202, 4 pp., explains the construction features of these pumps and gives advice about the applications they are suitable for. Dimensional drawing and table is given. A head capacity table is provided. Yeomans Brothers Co.

39 **Rubber Impeller Pumps**—This 50 pp., catalog describes all the different models of rubber impeller pumps. Each pump is described separately. List prices and head capacity tables are given. Drives which may be adapted are explained. Jabsco Pump Co.

40 **Small Air Compressors**—Form 714R, 20 pp., illustrates the several sizes of automotive type air compressors. Complete specifications given. Advantages of construction explained. Wayne Pump Co.

PROPERTY MAINTENANCE

41 **Monel Tie Wire**—Bulletin 9-M, 8 pp., presents the why of tie wire, the uses it covers, and how to install it. Installation and places it should be used are shown. Characteristics are given. International Nickel Co., Inc.

42 **Floor Repairs**—Bulletin 1-2-3, 6 page folder, describes the steps necessary for repairing rutted and cracked floors with this material. Stonhard Company.

43 **Stopping Corrosion**—A four page bulletin illustrating with photos and sketches how the coating made by this firm protects surfaces from corrosion. A list is given of the solutions which coating resists. Prufcoat Laboratories, Inc.

44 **Oil and Grease Absorbent**—Bulletin FB-14, 8 pages, explains the product of this firm that is spread on oil or grease soaked floors and which it is claimed will absorb the oil or grease which makes the floors dangerous for walking. Safety and Maintenance Co., Inc.

45 **Nailable Steel Framing**—This 20 pp. bulletin describes the steel framing to which any material can be nailed. Erection methods are shown in step-by-step sequence. Numerous photos show examples of how it can be used. Engineering data tables and safe loading tables with formula used are given. Accessories are illustrated. Stran-Steel Div., Great Lakes Steel Corp.

46 **Concrete Floors**—This 12 pp., bulletin tells the mixes of cement, stone, sand, and water to be used for both new floors and repairs to old ones. The correct preparation and application is shown in step-by-step photos with explanatory text. Lone Star Cement Corp.

TOOLS

47 **Cleaners for Small Tubes**—Bulletin J-410, 4 pp., describes and illustrates the entire Junior line of cleaners for small tubes. It also shows various types of cutter heads, brushes, lubricators, operating hose, and accessories. Roto Division, Elliott Co.

48 **Metallizing**—Bulletin No. 4-3, 12 pp., describes and illustrates the Type L metallizing gun for all types of repair work. The gun and all accessories needed are shown. Application photos show the types of work it may be used on. Metallizing Engineering Co., Inc.

49 **Controlled Lubrication**—Form 22-154, 12 pp., presents in color this firm's four basic systems of centralized lubrication. Each of these systems are for industrial use and so designed that one operation greases all spots on a machine needing lubrication. The equipment that makes up the systems and the accessories are also described with selection tables. Alemite Div., Stewart-Warner Corp.

50 **Tube Expanders**—Bulletin No. 43, 4 pp., describes and illustrates the tube expanders for use on boiler and heat exchanger tubes. Each type is shown with accompanying data. Tools, extensions, ratchets, for use with expanders are also described. Airetool Mfg. Co.

51 **Portable Power Tools**—Catalog No. 486, 22 pp., describes the many power hand tools for cutting, drilling, breaking, surfacing, and roughing, made by this firm. Also listed are the many accessories for use with the tools. Syntron Co.

52 **Pneumatic Tools**—Catalog No. 14, 60 pages, describes and explains these tools: drills, nut-setters, screw drivers, grinders, chipping hammers, riveting hammers, compression riveters, air hoists, air motors, and accessories. Specifications are given for each. Keller Tool Co.

PIPING, VALVES, VENTS

53 **Stainless Flanged Piping Systems**—Bulletin 483, 4 pages, includes drawings, dimensions, and prices of new type fittings and flanges available in stainless 304, 347, 316, and other materials. Taylor Forge & Pipe Works.

54 **Blow-Off Valves**—Bulletin E-120, 4 pp., presents in tabular form the many different types of blow-off valves offered. These include quick-opening straight lever, and rack and lever valves, slow opening rack and screw valves, angle, and five different duplex valves. Everlasting Valve Co.

55 **Air Venting Steam Equipment**—Bulletin No. 275, 4 pp., contains application descriptions of these air vents as applied to various industrial equipment. Dimensional drawings and tables with list prices are provided. Sarco Co., Inc.

56 **Compressor Air Check Valves**—Bulletin 509 describes the check valves for use on compressor outlets. Photos of the parts of valve and a sectional drawing show construction. Pennsylvania Pump & Compressor Co.

57 **Steam Pressure Drop through Separators**—This is a large fold out sheet from which it is possible to figure the pressure drop and capacity of this company's separator needed. Supplemental sheet explains how to use chart and gives sizes of separators available. Wright-Austin Co.

58 **Thread Sealing and Valve Lubricant**—Catalog No. 909, 4 pp., presents each of the compounds made for thread and gasket sealing and valve lubricating. The sizes of containers in which compounds are available is given. Parker Appliance Co.

59 **Stainless Steel Safety and Relief Valves**—This 4 page bulletin describes the several safety and relief valves made of stainless steel for different services. Sizes, and series are listed in table with list prices. Associated Valve & Engineering Co.

60 **Feeders and Rotary Valves**—Bulletin F-3, 8 pp., describes and illustrates with photos and dimensional drawings and tables, feeders and rotary valves. These are intended for use with granulated materials. Fuller Company.

WATER CONDITIONING, COOLING

61 **Evaporative Coolers**—Bulletin C-1100-B27A, 8 pages, describes these coolers and presents specifications, capacities, and accessories needed for both single and multiple engine installation. Worthington Pump and Machinery Corp.

62 **Diesel Performance Aids**—Form 6422 R, 4 pp., explains the three aids to better diesel performance available from this firm. Two are for cleaning cooling systems and the third for exterior cleaning. Oakite Products, Inc.

63 **Water Treatment**—A 20 pp., bulletin discussing the application of water treatment in industrial plants. Charts, photos, schematic drawings, and sketches illustrate the subjects treated: Boiler water. Condensate return systems. Cooling systems. Air conditioning systems. The eight operations of this firm's water treatment system are described. Bird-Archer Co.

64 **Cooling and Condensing Units**—Catalog No. 448, 8 pp., contains illustrations, diagrams and dimensions, and full descriptions of these units which are claimed to be immense. Outstanding features of construction are shown. Young Radiator Co.

65 **Heat Exchangers**—Bulletin 12-H, 12 pp., presents with photos and sectional drawings comprehensive data on single and two pass exchangers, vapor condensers, U-tube and tank type exchangers, fin tube units, and vent condensers. Dimension drawings and tables give the over-all sizes. Schutte and Koerting Co.

66 **Shell and Tube Heat Exchangers**—Bulletin No. 4300, 12 pp., illustrates the complete line of these heat exchangers and allied equipment. A brief description accompanies each photo. Ross Heater & Mfg. Co., Inc.

67 **Water Fountain Engineering Application Data**—Form TC-11, 6 pp., is solid engineering data to help the engineer figure the capacity of compressor, lines, fountains, for a given quantity of water to be consumed. Tai-Co. Mfg. Co.

INSULATION

68 **High Temperature Insulation**—This is a 24 page catalog of the complete group of insulations. Charts and illustrations on conductivity and installation of both plastic and block are given. Also included are data on blanket and pipe insulations. Forty-Eight Insulations, Inc.

69 **Heat Insulation Material**—Form No. 5329, 4 pp., explains with a conductivity chart comparing product with other types of insulation. Information as to sizes of sheet, pipe coverings, arc shaped for tanks, is given. Sketches show some typical applications. Philip Carey Mfg. Co.

70 **Mastic Asphalt Insulation**—Bulletin 1-648, 2 pp., describes the product of asbestos fibrated, emulsified asphalt in mastic form for protecting insulations from water, acid, spray and other corrosive liquids. Bitucote Products, Division of Bridges Paving Co.

MISCELLANEOUS

71 **Dust Collecting and Air Handling Equipment**—A 4 page circular to serve as an introduction to the several types of equipment made. Shown are blowers, bag type dust arrester, cyclones, and hydraulic collectors. Northern Blower Co.

72 **Gas Unit Heater**—This 4 page bulletin describes and illustrates with photos of complete unit and component parts and a phantom view this series C unit heater. Sizes and capacities are given in a table. Dimensional drawing and table provided. Automatic Gas Equipment Co.

73 **Permanent Magnetic Separators**—Catalog No. 12, 8 pp., describes the complete line of permanent non-electric magnetic separators. Complete specifications on weights, sizes and strength comparisons for various types are given with table of operating capacities. Eriez Mfg. Co.

74 **Industrial Switching Locomotives**—Bulletin GEA-3666B, 16 pages, describes and illustrates this 45 ton diesel-electric locomotive. Numerous tables, charts, help to explain the adaptability and photos show accessability. Apparatus Dep't., General Electric Co.

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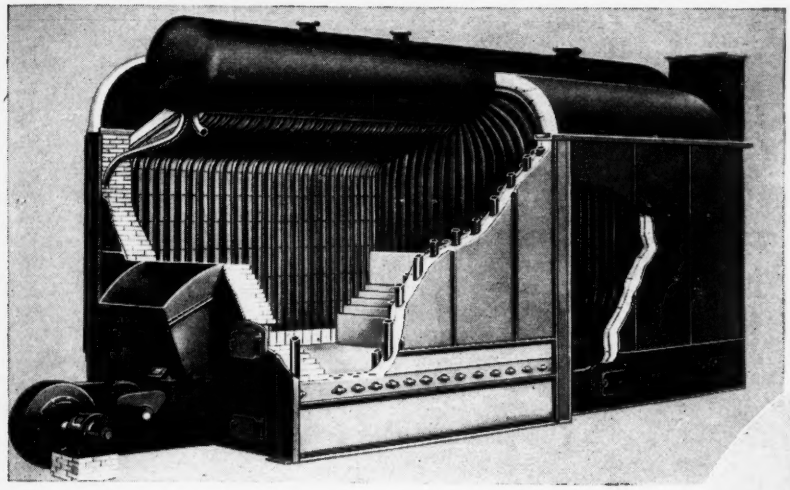
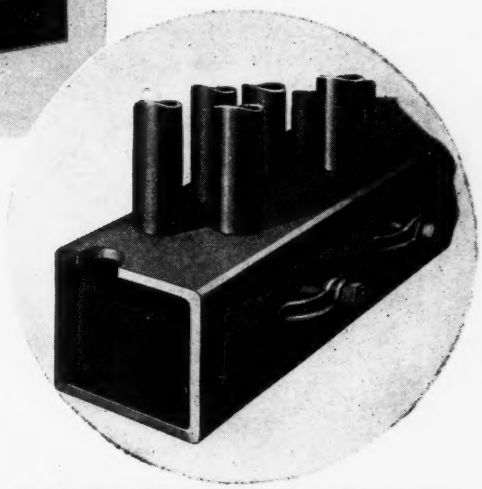
TYPE-VL *A Low Headroom*
2-DRUM WATER WALL BOILER



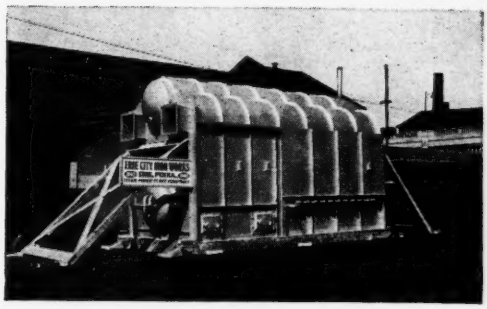
SHIPPED BUILT-UP IN SIZES TO 300 H. P.



Water Wall tube arrangement—1 Downcomer for each 2 Riser Tubes

Clean, Quiet, Circulating Water Taken From Top Drum

BACKED by a long experience gained in the manufacture of over 500,000 H.P. of Erie City 2-drum water tube boilers and of thousands of complete built-up boiler units, Erie City has incorporated side wall water cooling as an integral part of a low headroom 2-drum boiler. Outstanding of many features, is the method of obtaining a ring flow circulation, in each side wall element. A downcomer tube is provided for each pair of radiant (riser) tubes in the side wall, which, with two front wall downcomers assure an ample supply of clean circulating water in the water walls at all times. Insulation between riser and downcomer tubes keeps water at lower temperature in the downcomers while heat is rapidly removed from refractory through risers. Write for VL bulletin that clearly describes and illustrates this and many other features.



Shop assembled and shipped as a unit in sizes to 300 H. P.

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Complete Steam Generators • Type C 3-Drum Boilers • Type VL 2-Drum Boilers • The "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • Coal Pulverizers • Underfeed Stokers and Welded Pressure Vessels for the Process Industries.

ERIE CITY IRON WORKS • ERIE, PA. • *Since 1840*

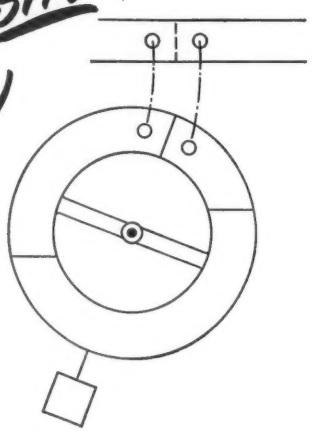
RING BALANCE METERS, SURE—

BUT BE SURE THEY ARE

HAGAN

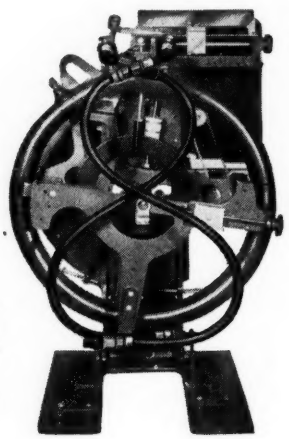
Ring Balance

this isn't new



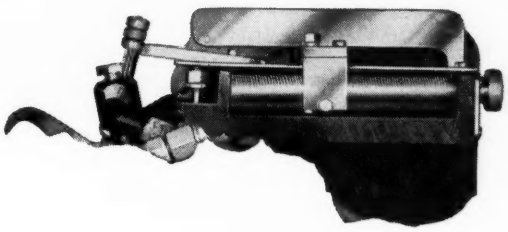
The ring balance principle is old, and flow meters based on this principle have been built both in this country and in Europe. But all of them, except the meter which Hagan now builds, had features which largely offset the advantages inherent in the ring balance principle.

this is new



One weakness of other ring balance type meters is that connecting lines, particularly when pressures are high, tend to restrict ring motion. In Hagan Ring Balance meters, this difficulty is completely eliminated in a most simple and direct fashion—by the use of S-shaped connecting tubes. This feature is patented, and is found only in these meters.

and this is new-



Adjustment of this spring by means of a simple range screw permits a change of as much as 7 to 1 in differential pressure. Even at low flows, this unique spring resistance system gives high accuracy in the conversion of differential head to pen movement. Patent is pending.

and so is this

The integrator, another patented feature of Hagan Ring Balance meters, is an independent unit easily added to or removed from a standard meter assembly. It is simple in design; accurate between 2% and 100% of meter range; calibrated by a single adjustment; and easily checked, either under test conditions or with the meter in service.

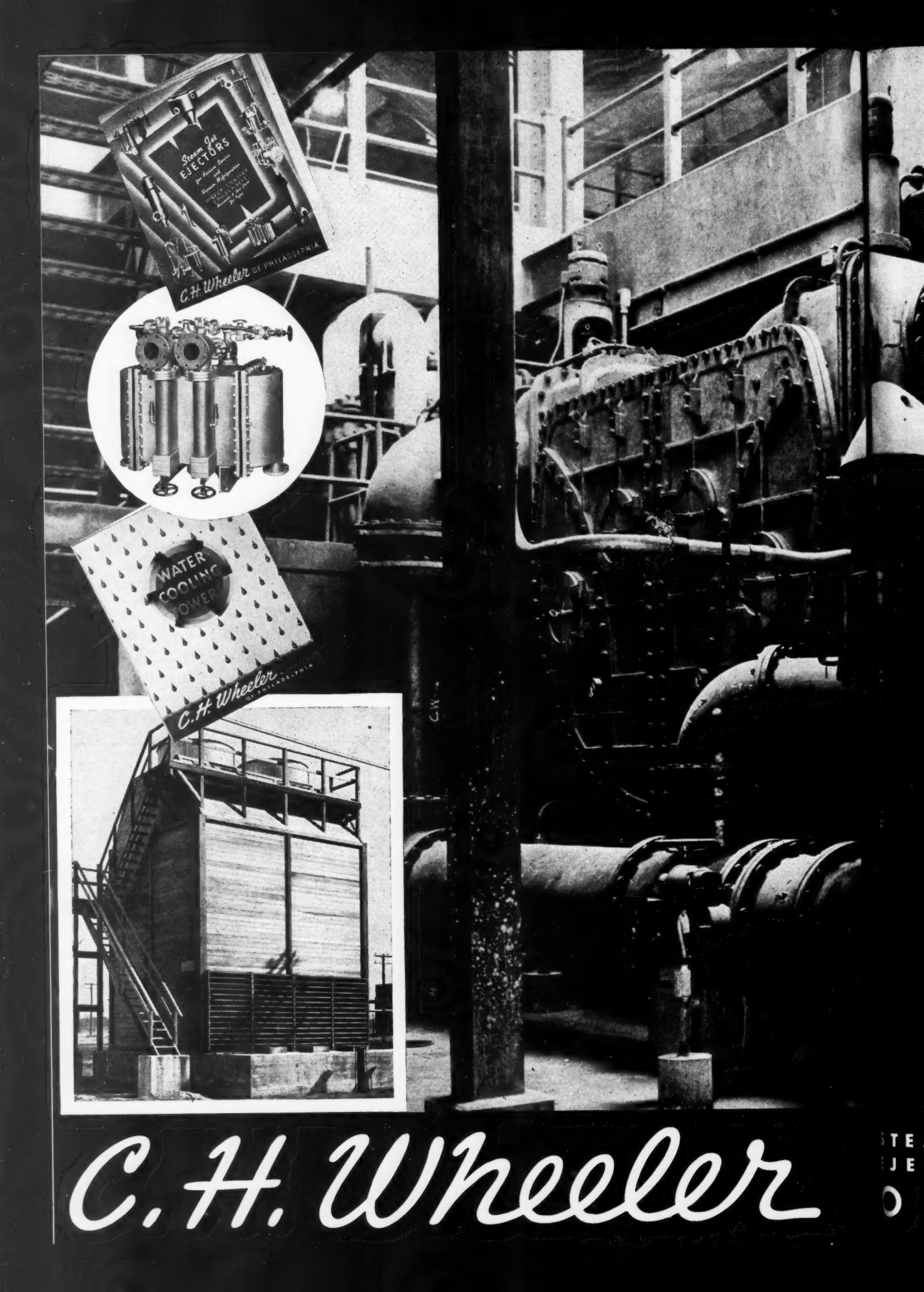
For full information on Hagan Ring Balance Flow Meters, write for Hagan Bulletin 2M48. Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

HAGAN BUILDING, PITTSBURGH 30, PA.

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES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240,000 "More" Sq. Ft. of Reverse Flow Condensers

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Six "more," patented C. H. Wheeler "Reverse Flow," Dual Bank Surface Condensers with Divided Water Boxes, totaling nearly a quarter million square feet, will soon be added to the many now in service. Possibly you, too, can save money or simplify your next condenser installation with a C. H. Wheeler "Reverse Flow," in which the tubes and tube sheets are cleaned by reversing the direction of water flow, without drop of condenser efficiency. "Reverse Flow" saves the installation of filters, screens, etc., where the supply source of condenser circulating water contains trash, leaves, etc. Further, C. H. Wheeler "Reverse Flow" does not require any additional piping over that of standard condenser installations. They are available, and prove a quick, self-liquidating investment in any size, the smallest now operating being 9000 sq. ft. and the largest being 50,000 sq. ft. Write for more information and for Cat. No. 1461, "Steam Condensers," which describes the advantages of "Dual Bank"; also get Cat. No. 145, "Water Cooling Towers" and Cat. No. 1462, "Steam Jet Ejectors."

C. H. WHEELER MANUFACTURING CO.
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STEAM CONDENSERS • WATER COOLING TOWERS
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OVEN TEST COOKS UP LONGER LASTING PRODUCTS

QUAKER PRE-TESTED PRODUCTS FOR THE POWER FIELD ARE PERFORMANCE-PROVED THROUGHOUT THE NATION

It may be called the "Oven Test," but to the buyer of Quaker Rubber Products it means producing rubber with the ability to withstand heavy static loads.

In making Quaker Rubber Hose it results in compounds of controlled specifications that will hold couplings over long periods of time . . . prevent hose from relaxing and allowing couplings to loosen. In packings, this pre-testing assures finished products that will hold their shape, will not relax, readily withstand pressures without the danger of blowouts.

This is only one of eighteen rigid tests that raw materials and finished products *must* pass before receiving the Quaker stamp of approval. Pre-testing provides quality and long service . . . assures worthwhile dividends for you through higher plant efficiency, lower operating costs. Call in your nearest Quaker distributor for hose, belting and packings.

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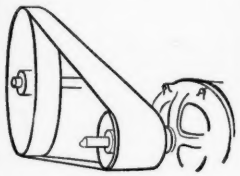
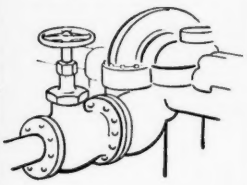
WHAT QUAKER Pre-Tested Products mean to the Power Field



STEADY GRIP . . . LESS SLIP

Quaker V-belts and flat belting are pre-tested to provide plenty of grip, plenty of pull for more power. Pre-tested rubber stays flexible, withstands aging and abrasion.



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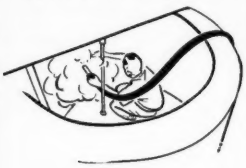
Quaker pre-tested packings for all purposes keep pressure in . . . stop leaks on valve stems, piston rods, flanges. Made of pre-tested materials for long life.



LONG SERVICE AT HIGH PRESSURE

Quaker hose provides low-cost handling of steam, air, liquids, volatiles. Pre-tested rubber remains pliable, flexes easily, combats breakdown.

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ENGINEERING SERVICE

When belting, hose, and packing problems bog down efficiency in your plant, call your Quaker Distributor for a quick solution.

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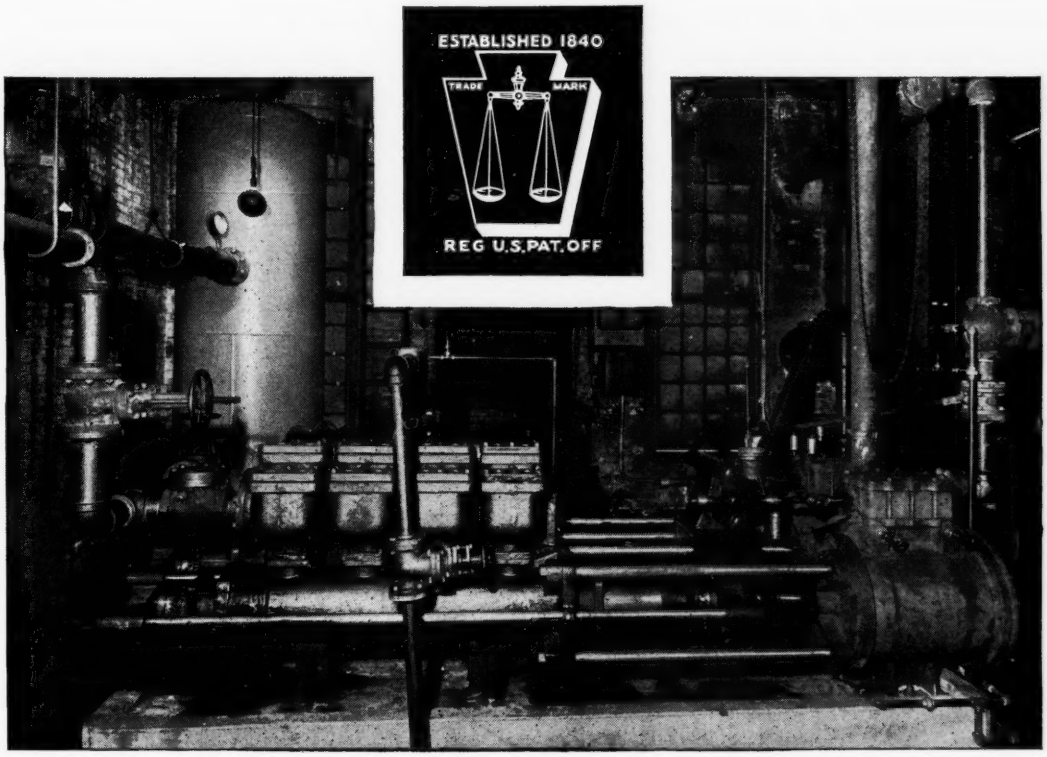
Another famous user of WARREN PUMPS



HENRY DISSTON & SONS, INC., Philadelphia, are the largest and oldest manufacturers of hand saws in the world, having been in continuous operation since 1840.

One of the important services performed by Warren Pumps in the Disston 65 acre plant is providing hydraulic pressure for presses to flatten and straighten heat treated saws. The pump illustrated is a Warren 18 x 6 x 18 Horizontal Duplex Plunger type and it is in continuous operation 16 hours a day the year round at between 550 and 600 lbs. discharge pressure.

For over fifty years Warren has designed and built pumps that have consistently resulted in low operating costs, minimum maintenance, and dependable, uninterrupted production in thousands of nationally known plants. If you are interested in this kind of pumping service, why not contact us or your nearest Warren representative?

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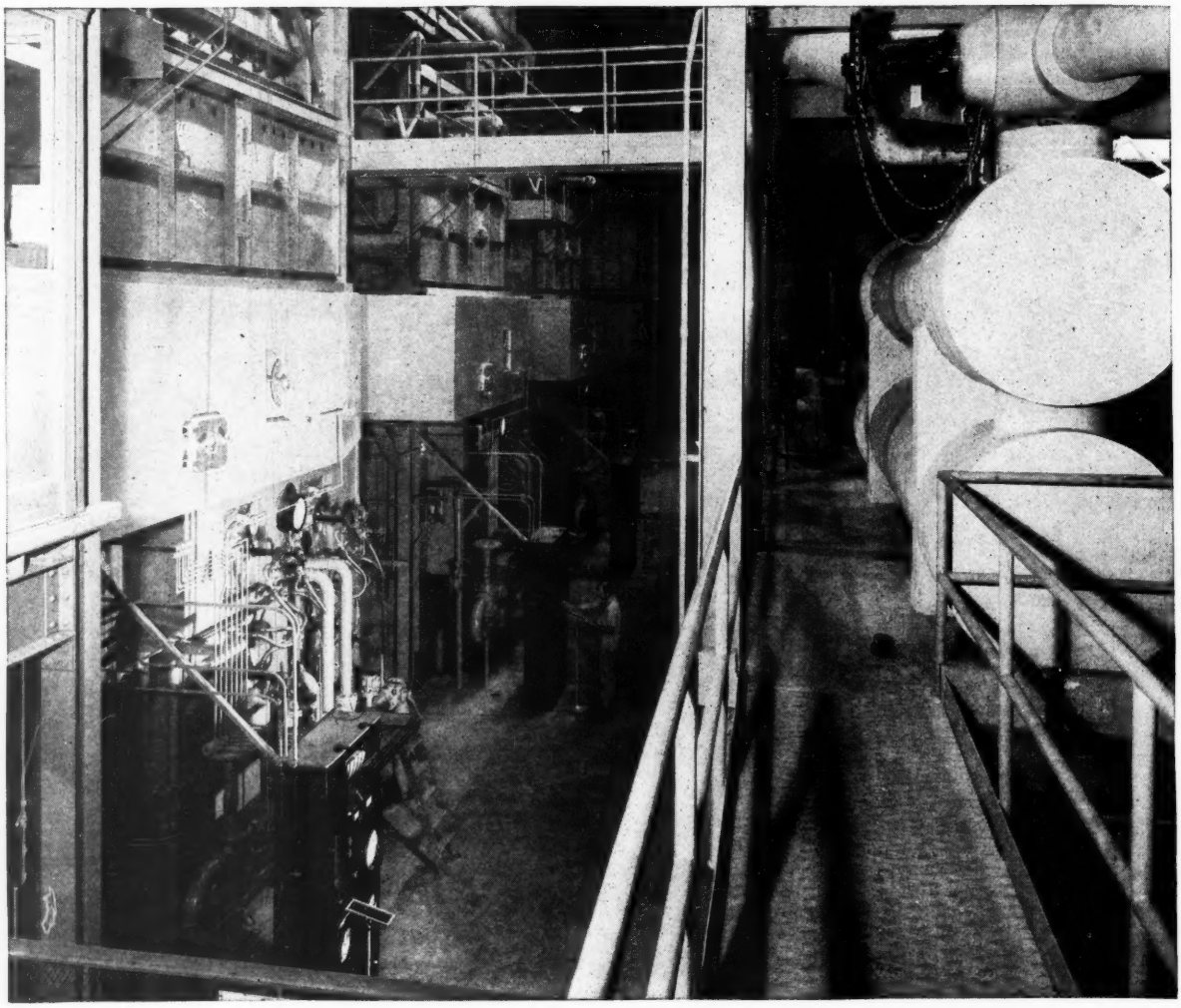

Interior view of a 400,000 lb. steam generating plant in a modern industrial plant. Steam is generated in these gas fired boilers which are operated by a Republic automatic combustion control system.

The installation of Republic automatic controls on your boiler (or boilers) will enable you to:—

SAVE FUEL by automatically maintaining highest combustion efficiency.

INCREASE STEAM OUTPUT by operating the boilers at test efficiency 24 hours a day, 7 days a week.

CONSERVE MANPOWER by automatically performing the many routine repetitive adjustments.

REDUCE OUTAGES by maintaining uniform operating conditions and thereby prevent the chain-of-event type of trouble that frequently develops as a result of incorrect boiler operation.

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INSTRUMENTS
AND CONTROLS

Combustion Control Systems

ARE BEING SPECIFIED THAN EVER BEFORE

because...

Built into the Republic combustion control systems are the many important features that enable it to fulfill all the conditions of theoretically perfect combustion control and still meet all the demands of everyday operation.

Check the following features against your list of "musts" when specifying a perfect combustion control system.

CENTRALIZED CONTROL:
The operation and control of the boiler or boilers is centralized at the master controller.

FUEL-AIR RATIO INDICATOR:
The master controller is provided with mercury manometers or gages which indicate the measured fuel and air inputs to the boiler and the fuel-air ratio.

FUEL-AIR RATIO ADJUSTMENT:
A handwheel on the front of the master control panel provides a convenient means for adjusting the fuel-air ratio.

FUEL VARIATIONS:
Automatically compensates for variations in fuel to maintain combustion conditions constant.

ALL BOILER RATINGS:
Maintains proper fuel-air ratio over the entire range of boiler ratings.

CONSTANT STEAM PRESSURE:
Maintains the plant steam pressure within narrow limits of variation by proportioning the fuel and air inputs to the load.

LOAD DISTRIBUTION:
Provides a means of distributing the load among the boilers as desired.

MANUAL CONTROL:
Boiler ratings can be controlled manually by a handwheel located on the front of the panel.

Find out about Republic control systems. One of our engineers will be glad to consult with you at any time without obligation on your part. Write us today.

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NOW YOU CAN

CONDENSE OR COOL

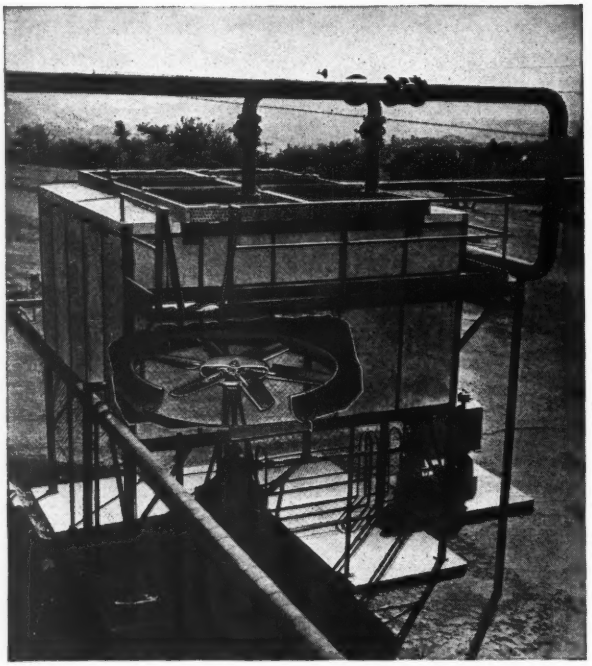
WITHOUT WATER

WITH THE

FIN-FAN

AIR-COOLED

Heat Exchanger



AIR . . . not water . . . is the cooling or condensing medium in the FIN-FAN Heat Exchanger. With this unit, you avoid all the complications and expenses of a water supply system . . . no water piping, pumps, treatment, disposal or make-up; no corrosion, scaling, freeze-ups, or structural repainting due to use of water.

In the FIN-FAN Exchanger you have a unit that is simple, easy and economical to operate and that may be placed in any convenient location. It can be used to condense vapors or to cool gases and liquids at pressures up to 5000 psi and temperatures up to 1500°F., and its effectiveness is independent of the velocity or direction of the wind. In addition, one of its special advantages is that a single installation can be arranged to handle multiple duties.

Be sure to investigate the possibilities for your own plant in this exchanger of many applications and many benefits. Complete information sent on request.

Write for Bulletin

G-R Bulletin 1230 fully describes the design, construction and features of this important development in heat exchangers, jointly developed by Fluor Corporation, Ltd., and The Griscom-Russell Co. Write for your copy today.

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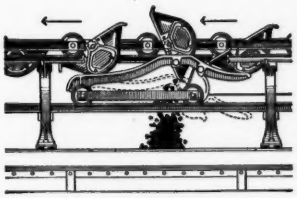
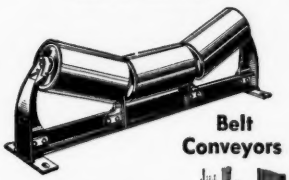
LINK-BELT EQUIPMENT

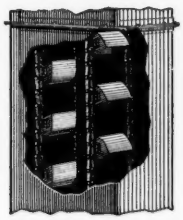
Meets Every Need of Industry in Handling Coal and Ashes



Bucket Carriers



Belt Conveyors



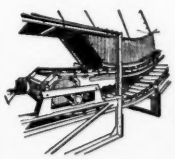
Bucket Elevators

Bulk-Flo

Screw Conveyor

Skip Hoist

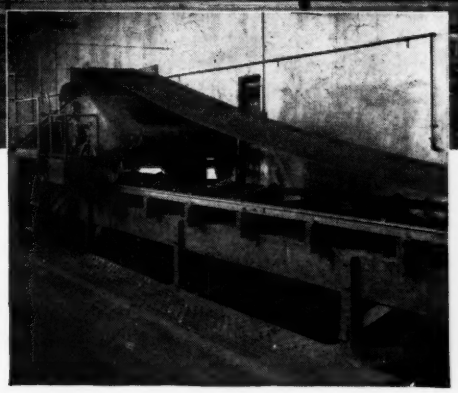
Coal Crusher



Feeders

Car Dumper

Weigh Larry



Versatile Coal System Handles 450 T.P.H. of Bituminous Slack

This coal handling system is very versatile in that it is arranged to receive coal by river barge or railroad car and convey it to either the boilerhouse bunker or reserve ground-storage, at the rate of 450 tons per hour, as well as handle coal from reserve storage to bunker when necessary. A tank type self-propelled and self-reversing belt tripper operates to distribute the coal inside the plant.

Completely engineered by Link-Belt, the belt conveyor system includes six 36 in. wide units of varying lengths, with three feeder conveyors under receiving hoppers. Link-Belt self-aligning troughing idlers are used at intervals, and Link-Belt differential band brakes are used to prevent backward motion of loaded inclined conveyors in case of power failure.

We'll be glad to give you complete details of this and other power plant coal handling systems. Get in touch with our nearest office.

LINK-BELT COMPANY

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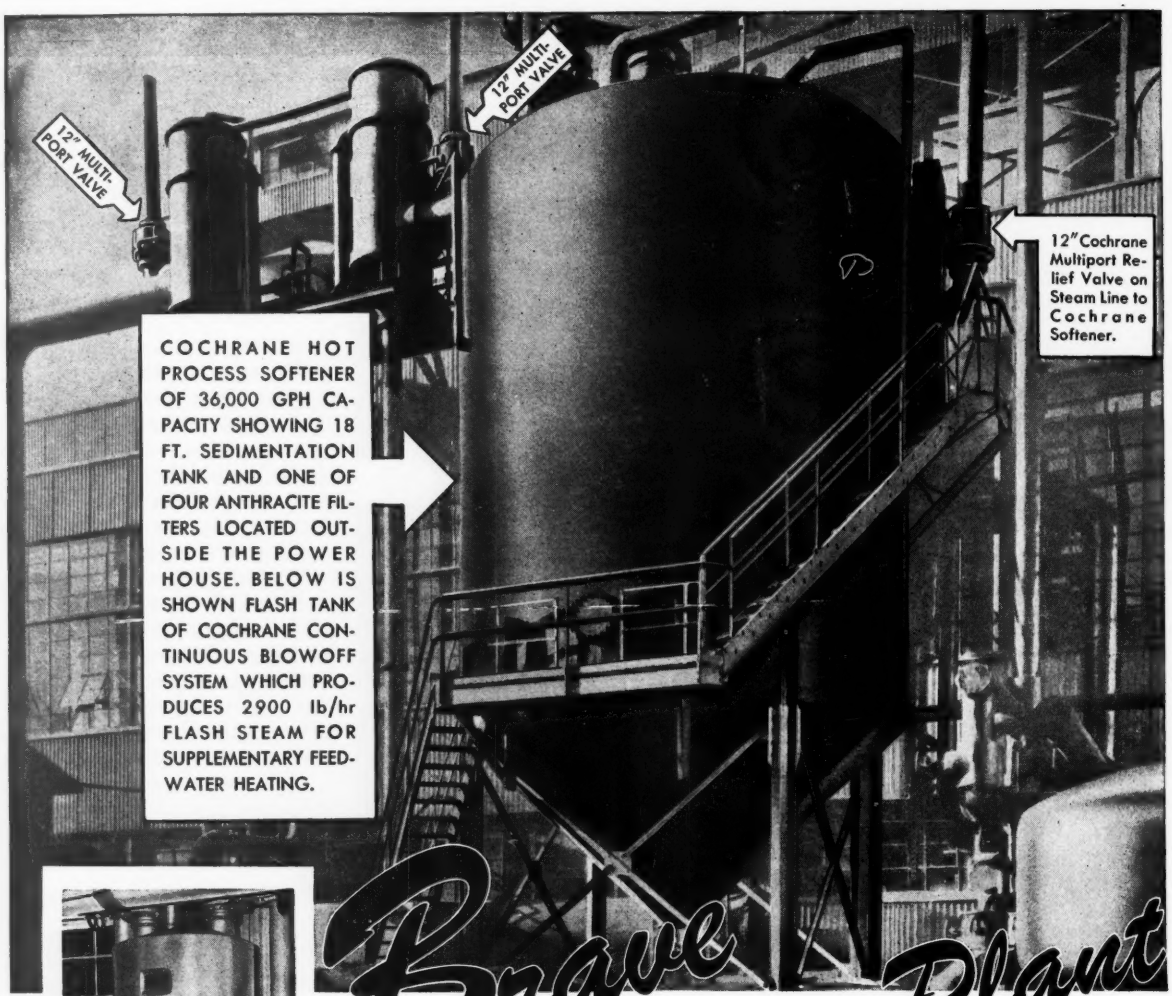
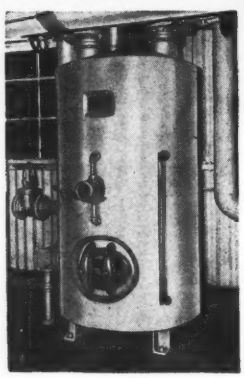
THE SYMBOL OF QUALITY — LB — LINK-BELT

COAL AND ASHES HANDLING EQUIPMENT


12" MULTI-PORT VALVE
12" MULTI-PORT VALVE
12" Cochrane Multiport Relief Valve on Steam Line to Cochrane Softener.
COCHRANE HOT PROCESS SOFTENER OF 36,000 GPH CAPACITY SHOWING 18 FT. SEDIMENTATION TANK AND ONE OF FOUR ANTHRACITE FILTERS LOCATED OUTSIDE THE POWER HOUSE. BELOW IS SHOWN FLASH TANK OF COCHRANE CONTINUOUS BLOWOFF SYSTEM WHICH PRODUCES 2900 lb/hr FLASH STEAM FOR SUPPLEMENTARY FEEDWATER HEATING.



Brave New Power Plant

with COCHRANE HOT PROCESS SOFTENER

COCHRANE CORPORATION 85 YEARS OF SERVICE 1863-1948

AT BRAVE, a village in southwestern Pennsylvania, the People's Natural Gas Company have a compressor station for which a new power plant was required. The Machinery Division of Dravo Corporation, Pittsburgh, was chosen to build the power plant. Obviously, all equipment selected was such as to insure the highest efficiencies combined with operating economy.

The result justifies this selection for not only is the compressor station handling more gas today than at any previous time in its history but coal consumption has been cut 100 tons per day!

The feedwater (100% makeup) for the boilers is obtained from a nearby creek and is treated in a 36,000 GPH Cochrane Hot Process Softener. A Cochrane Continuous Blowoff System maintains uniform boiler concentrations and provides low pressure steam for supplementary feedwater heating. The famous Cochrane Multiport Relief Valves are also used in this installation, one on the steam line to the softener and two on the barometric condensers.

Literature describing this equipment may be had by writing COCHRANE CORPORATION, 3123 North 17th Street, Philadelphia 32, Pa.

COST-CUTTERS YOU CAN DEPEND ON!

Worthington Turbine-Generators Set The Pace For Economical, Trouble-Free Operation

Two Worthington 2500 kw, 3600 rpm, 13,800 volt, 3-phase, 60 cycle Turbine-Generator Units at the Kaiser-Frazer plant in Willow Run, Michigan. They operate on steam at 250 lb. initial pressure, 470° F. total temperature, and exhaust at 27½" vacuum. Steam is automatically extracted at pressures from 15-50 lb. Installed in 1941, these Worthington Units supply both electric power and extracted steam for plant heating.

Worthington builds Turbine-Generator Sets in sizes up to 7500 kw, and in all types—including straight condensing, straight non-condensing, extraction, mixed pressure, mixed pressure extraction, low pressure and high back pressure.

Throughout industry these units are generating lower cost power, requiring only minimum maintenance, chalking up records of 99% — and better—for continuous operation, year after year.

IN YOUR OWN PLANT

Worthington engineers will be glad to study your power requirements, and to give you an estimate of the savings possible with the Worthington Unit that best meets your particular needs.

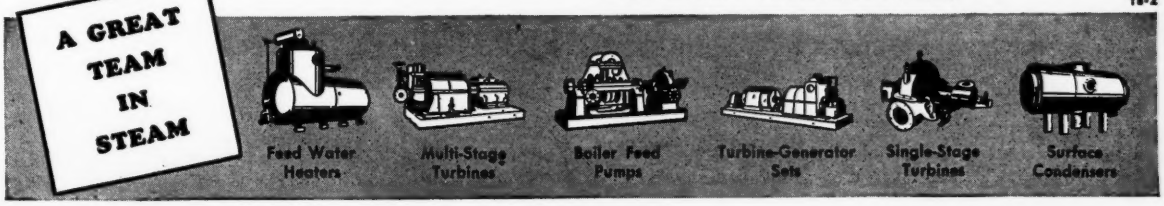
For further details proving *there's more worth in Worthington*, call your nearest Worthington District Office, or write to *Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, N. Y.*

WORTHINGTON

STEAM TURBINES

TS-2

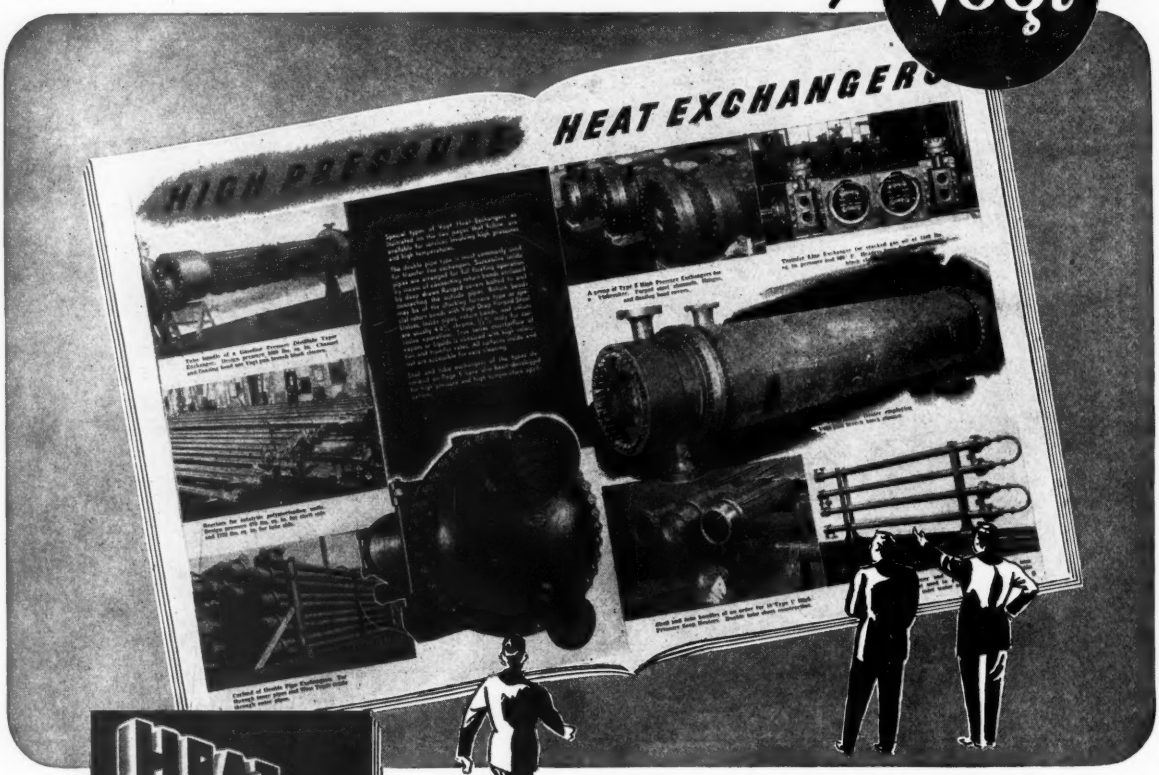
A GREAT TEAM IN STEAM



Presenting

a pictorial record of standard and special built HEAT TRANSFER EQUIPMENT

by Vogt



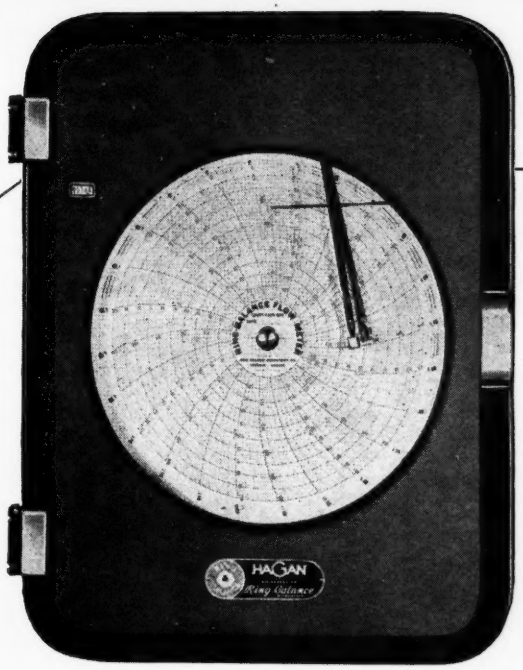
Write for a copy of Bulletin HE-5, on your letterhead.

You are invited to send for this record of ingenuity in heat exchanger design and construction.

Shown, among examples of the many types we build, are units for diversified applications, high pressures, and special operating conditions as well as conventional types for ordinary exchanger services in petroleum refineries, chemical plants, process industries, power plants, etc.

Thousands of installations in successful operation attest to Vogt's ability to give effective help in the solution of heat transfer problems peculiar to a wide variety of operating conditions.

HENRY VOGT MACHINE CO.
INCORPORATED
LOUISVILLE 10, KENTUCKY
BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS



Boiler Meters By HAGAN

The accuracy and dependability of Hagan Ring Balance Flow Meters make them especially suitable for boiler plant applications, either as a guide in the operation of manual combustion control systems or a check on the operation of automatic systems.

Meters are available for virtually any type of flow measuring application. Among the most widely used types, however, is the boiler meter shown here which records both steam flow and air flow on the same chart. This meter is so designed that auxiliary records of flue gas temperature, feedwater temperature or steam pressure may be added if desired.

For full information on Hagan Ring Balance Flow Meters, write for Hagan Bulletin 2M48. Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.

HAGAN CORPORATION

HAGAN
HALL
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CALGON

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

Chlorination...

REDUCES CONDENSER "DOWN-TIME"

When high back-pressure due to slime fouling on condenser water-side surfaces results in excessive down-time and costly plug cleaning, the best "doctor" is chlorination. Here's why:

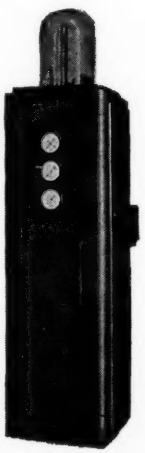
Properly applied chlorination by means of a job-engineered W&T installation is economical. In most cases, the cost of the equipment is saved in the first year.

Chlorination gets at the source of the trouble by killing the micro-organisms that cause slime deposits.

Plug cleaning is eliminated and equipment may be kept on the line thus, in effect increasing station capacity.

Fuel costs are reduced through reduction in average back-pressure.

W&T's more than thirty years' experience in water treatment are always at your call. Write today for a survey of your cooling water system—there's no obligation.



WALLACE & TIERNAN
PRODUCTS, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
Belleville 9, New Jersey • Represented in Principal Cities

CD-29

WICKES
PACKAGED-POWER
TYPE-A STEAM GENERATORS

Wickes Package Type-A Steam Generators are compactly designed for immediate installation with the *least possible installation problems* and disruption of production schedules. Designed to conserve headroom and floor space, Type-A Steam Generators are steel-encased package type units with casing, baffles, refractories, pressure parts, burners and floor all assembled. Engineered for pressures up to 850 psi, with sustained steam production of 20 to 275 nominal HP, producing up to 35,000 lbs. steam per hour, the Wickes Type-A Water Tube Steam Generator is a quick steamer, *requiring minimum maintenance and operating attention.* Consult Wickes first. We are completely equipped to design and build boilers to specific requirements.

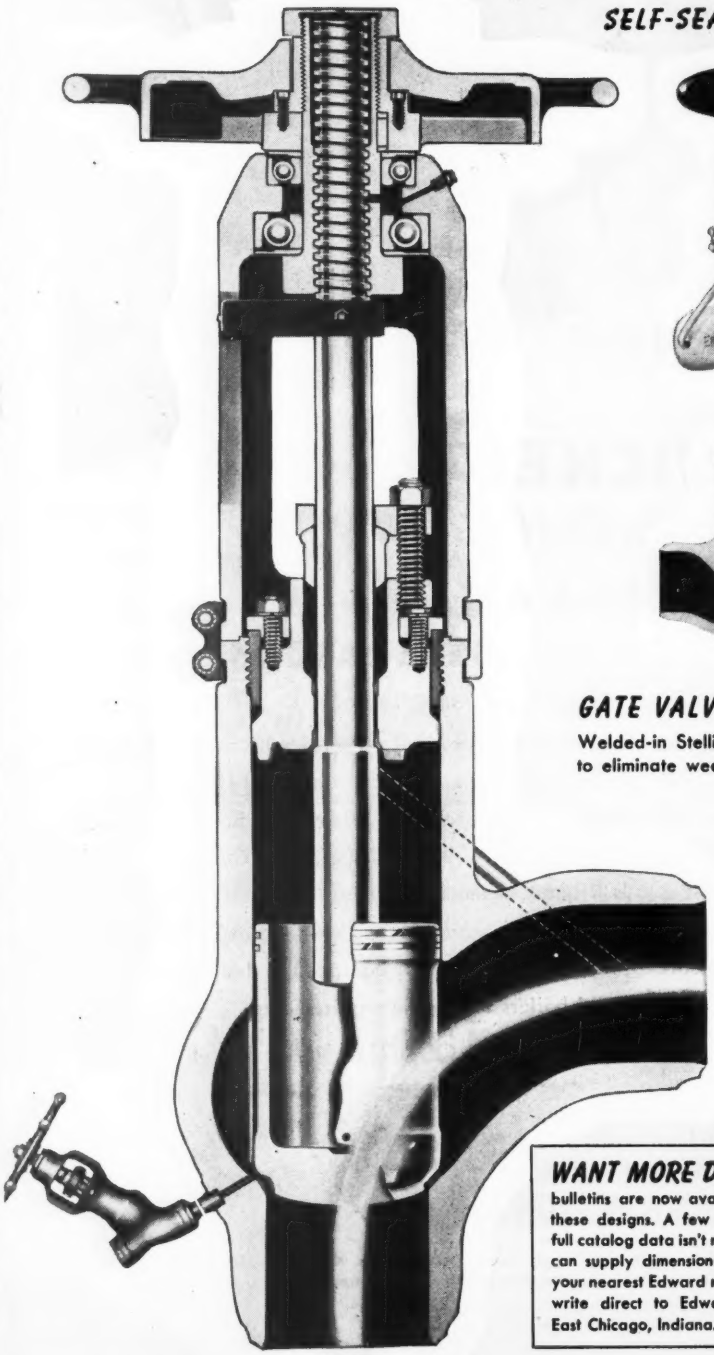
RECOGNIZED QUALITY SINCE 1854

THE WICKES BOILER CO.
DIVISION OF THE WICKES CORPORATION
SAGINAW, MICHIGAN

SALES OFFICES: Atlanta, Boston, Charlotte, N. C., Chicago, Cincinnati, Denver, Detroit, Houston, Indianapolis, Kansas City, Los Angeles, Milwaukee, New York City, Pittsburgh, San Francisco, San Jose, Seattle, St. Louis, Tulsa, Mexico City, Buenos Aires.

They're New!

NEW PRESSURE SEAL BONNET VALVES.. NEW FORGED STEEL GLOBE VALVES.. NEW IMPACTOR HANDWHEELS..NEW

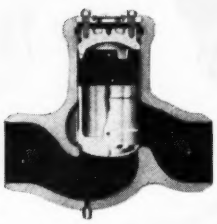


SELF-SEALING BONNET JOINTS, 30% MORE FLOW

Now you can get Edward pressure-seal bonnet valves in gate, globe or angle patterns for stop, check or non-return service. New features for lower and lower pressure drop have been built in—and **proved.** On no other valve series is there more proven flow data.

EDWARD PATENTED EVALTHRUST YOKE BUSHING

and Impactor handwheel for easiest closing in cramped locations is standard on stop and non-return series. So is closure indicator.



ON CHECK VALVE, left, and non-return valve, far left, note new enclosed dash-pot disk, Edward Equalizer for high disk lift and free flow passage. The whole series is regularly built in chrome-moly steels for stability at high temperatures.

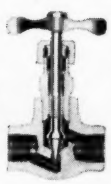
GATE VALVE THAT STAYS TIGHT

Welded-in Stellited seats, welded-in guide ribs to eliminate wedge drag on seating faces, ball bearing operation clear down to 4 or 5 in. sizes—these and many other features are standard—not added cost extras—in the new Edward gate valves

WANT MORE DATA? Special bulletins are now available on most of these designs. A few are so new that full catalog data isn't ready yet, but we can supply dimensional drawings. Ask your nearest Edward representative, or write direct to Edward Valves, Inc., East Chicago, Indiana.

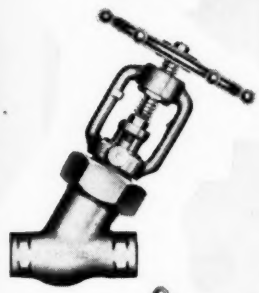
A WHOLE NEW GROUP of Edward Steel Valve Designs

HANDWHEELS..NEW GAGE VALVES..NEW WELDED BONNET UNIVALVES..NEW BLOW-OFF VALVES...NEW GATE VALVES



FINE REGULATION ON GAGE LINES

For gage and meter service, the redesigned Edward Fig. 152 valve gives close flow regulation with small seat port and longer seat-stem contact area. New form fitting T-Handle. Rated 4000 lb W.O.G. Also in 12% Cr. and 18-8 stainless steels.

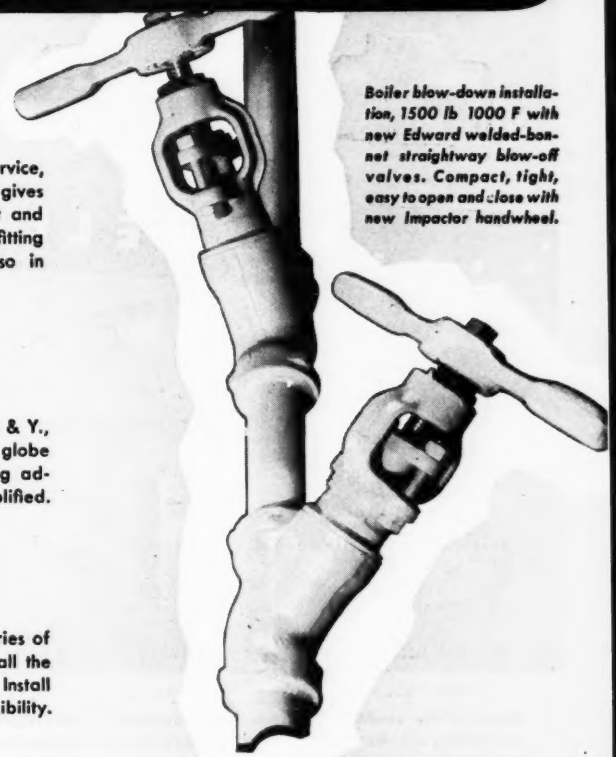


ALL-PURPOSE SMALL GLOBE VALVE

Here's a new O. S. & Y., union bonnet, bolted gland forged steel globe valve for a multitude of services. Packing adjustment or replacement greatly simplified. Rated 800 lb, 750 F.

BLOW-OFF FLEXIBILITY

A new series of 300 lb O. S. & Y. blow-off valves with all the design features of high pressure valves. Install them in any position for greatest piping flexibility.



Boiler blow-down installation, 1500 lb 1000 F with new Edward welded-bonnet straightway blow-off valves. Compact, tight, easy to open and close with new Impactor handwheel.

NEW, EASIER CLOSING

Now the Edward Impactor handwheel, modernized and improved, is available on many small valves as well as large. Easy-to-grip cross bar delivers 2.8 times the closing load of ordinary handwheels. No wrenches or extension bars needed.

NEW WELDED-BONNET UNIVALVE

Already lowest in pressure drop among forged steel globe valves, Edward patented welded bonnet Univalves have been modified to give even less resistance to flow, less wear-producing turbulence. For top temperature service and up to 2500 lb pressure, here is the valve that offers the most.

Edward Valves, Inc.

SUBSIDIARY OF ROCKWELL MANUFACTURING CO. EAST CHICAGO, INDIANA

SEE THEM AT THE POWER SHOW

These new designs, and many other Edward and Nordstrom lubricated plug valves too, will be on display at the Edward booths, No. 26 and 27 at the Power Show, Grand Central Palace, New York, Nov. 29 to Dec. 4.

Accept no less than the FULL LINE!

Whatever the conditions: Extreme temperatures . . . . extreme pressures . . . . steady flow or shock service . . . . corrosion resistance . . . product purity.

Whatever the material: Forged carbon steel . . . wrought iron . . . . carbon or chrome moly . . . . Stainless 304, 347, 316 . . . . Monel . . . . Nickel . . . . Inconel . . . . Aluminum . . . . other usual industrial materials.

Whatever the size or weight: Forge-formed fittings in the entire size range from ¾" all the way to 30" (or larger!): in all the usual or special weights necessary for *any* service condition; with a companion range of seamless forged and forge-rolled flanges of every type, in *all* ASA sizes and pressure series, or beyond, as large as 96" diameter.

Whatever your requirement: Taylor Forge provides the most complete line. Accept no less!

TAYLOR FORGE

TAYLOR FORGE & PIPE WORKS General Offices & Works: Chicago 90, Ill. (P.O. Box 485) Eastern Plant: Carnegie, Pa. Western Plant: Fontana, Calif. • District Offices—New York: 50 Church Street • Philadelphia: Broad Street Station Bldg. Chicago District Sales: 208 S. LaSalle Street • Houston: City National Bank Bldg. • Los Angeles: Subway Terminal Bldg.

Get Catalog 484 Just out!

Brand-new Taylor Forge Catalog 484 brings you up-to-date on welding fittings and flanges, and the technical data you want at your elbow. Send for your copy!

Send me catalog 484

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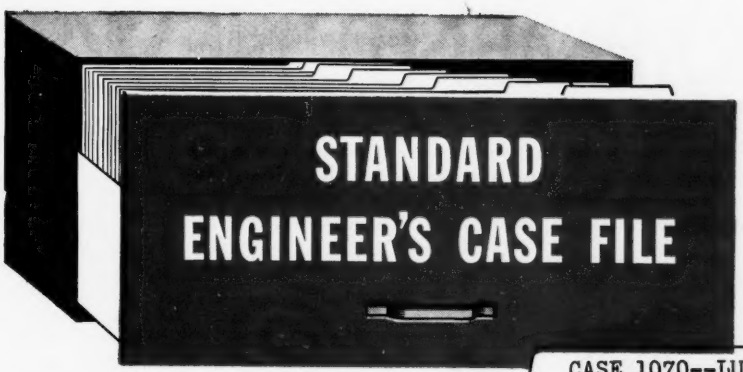
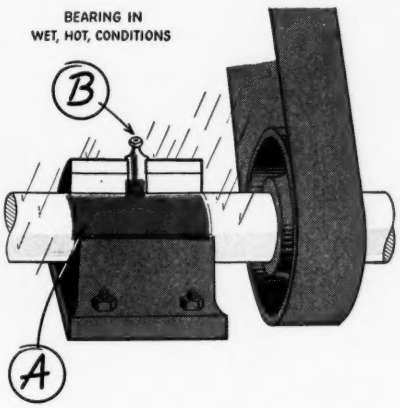
MAIL TO TAYLOR FORGE & PIPE WORKS
P.O. BOX 485, CHICAGO 90, ILL.



CASE 1070--LUBRICATING GREASE BEARINGS IN HEAT AND MOISTURE.



In a heavy water spray and high ambient temperatures, Calol W. P. Grease maintained good bearing lubrication for full lubrication periods. Very satisfactory on wicket gates of hydro-electric turbines, coal loader arms, hot bed and conveyor bearings in water conditions, cannery and bottle-washing equipment.

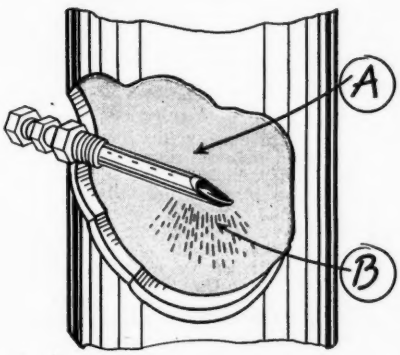
A. Extremely adherent to metal surfaces ... maintains tough lubricating film.

Calol W. P. Grease will not melt or dissolve in boiling water. Resists all heat in a peculiar manner - gradually softens over long range of temperatures instead of melting suddenly as most greases do.

B. Medium-bodied -- may be applied by grease gun or cup. Good pumpability in low temperatures.

Calol W. P. Grease contains no talc, resin, wax or other fillers.

CASE 1040--SECURING SAFE LUBRICATION IN STEAM ENGINES IN WIDE RANGE OF CONDITIONS.



LUBRICANT ATOMIZING QUILL

Compounded Calol Cylinder Oil — 155PX provided adequate lubrication with freedom from carbon in various steam engines operating with temperatures from 375° F. to 550° F. Made from 100% Pennsylvania steam cylinder oils and special acidless tallow oil. Medium viscosity grade.

A. Economical in steam conditions from saturated to moderate superheat.

B. Atomizes readily in steam.

Calol Cylinder Oil — 155PX will separate easily from exhaust steam and condensate where adequate oil separators and skimming equipment are installed.

Calol Cylinder Oil — 155PX is one of a complete line of steam cylinder and valve oils produced by Standard of California.

For additional information and the name of your nearest Distributor, write

STANDARD OIL COMPANY OF CALIFORNIA
225 Bush Street, San Francisco 20, California

The California Oil Company
Barber, New Jersey

The California Company
17th and Stout Streets, Denver 1, Colo.

Standard Oil Company of Texas
El Paso, Texas

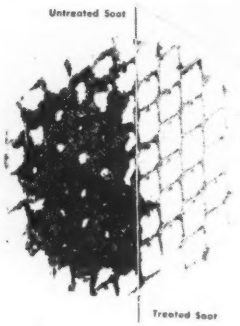
RPM CALOL

Trademarks Reg. U. S. Pat. Office

NEW EQUIPMENT NEWS

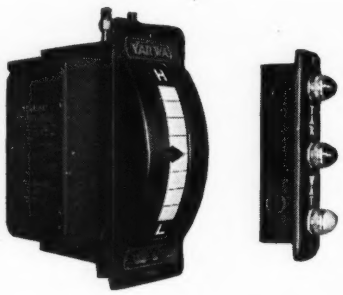
Use the coupon below when you want further information on the equipment described on this page and following pages. Write the identifying letter or letters in the space provided, clip the coupon and send it to Power Generation, 53 West Jackson Boulevard, Chicago 4, Illinois

A Soot Remover. A new chemical soot remover is announced. SR-150 removes soot by lowering its ignition temperature to 750 F, where normal furnace temperatures will burn it off. Untreated coal soot burns at about



1135 F. Feeding of SR-150 may be done under normal furnace operating conditions. The material is furnished in powder form, which vaporizes completely on contact with the fire bed. These vapors penetrate the soot and bring about ignition. National Aluminate Corp.

B High-Low Water Signals. To extend the use of its remote liquid level indicator, this company has developed a new attachment for operation of one or more distantly located electric type visible or audible high-low alarm signals and/or controllers for pump motors or other devices in steam power stations and industrial plants. The new control unit is attached directly to the Indicator, which is operated by the boiler water itself and registers all variations of the level in boilers, feed water heaters and other storage vessels.



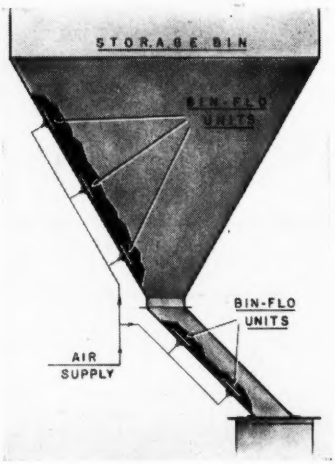
The control unit consists of simple two-pole curved-bar permanent magnet fixed to shaft of indicator pointer and actuating one or the other of two sealed-in-glass mercury switches which in turn operate the hi-lo alarm signals installed at remote locations where additional check on the liquid level may be required. The visible signal shows red light at top or bottom for high level or low level condition corresponding to high-low positions of indicator pointer; center lense shows green or amber during normal level range of indicator. Audible hi-lo signal uses two vibrating horns of different tones or a single horn for both high and low levels. Yarnall-Waring Co.

C Drum Wrench. No. 5001, universal type wrench, has sockets and lugs so placed to fit all standard steel drum closures. Also has a steel lip for removing steel caps over drum closures. The wrench will fit male, female and hexagon drive closures. Also closures

driven by internal lugs; is made of cast steel, cadmium plated to prevent sparking. Price, $3.00 ea. Weight is 2½ lbs. Aero Tool Co.

D Bin Aerator. Announced is Bin-Flo, a new aerating device to provide uniform and steady flow of bulk materials from bins, hoppers, and chutes.

Bin-Flo provides a new and economical solution to the restriction and stoppage of bulk materials in bins and chutes. The unit is a small plate 3¾ by 7½ by ½ in. thick which is readily located at points where flow is restricted. Low-pressure air is injected into the material through a special fabric diffuser, causing the material to flow freely. It is claimed units will not



plug-up even with the most finely ground material and are applicable to most dry, finely-ground materials. Models are provided for thin-walled bins and chutes and for concrete and other thick-walled hoppers. Piping can be run either outside of thin-walled bin or inside of thick-walled container. Bin-Dicator Co.

E 600-lb Steel Gate Valves. Announced is a new line of union bonnet 600 lb cast-steel gate valves. The new valves have been designated No. 3602XW and 3602X, and will replace the No. 3606XW and 3606X, which are being discontinued. The new valves are available in sizes ¼ through 2 in., with screwed ends and with two kinds of trim. The 3602XW has Exelloy seats and a hardened stainless-steel disc; the 3602X has both seats and disc of Exelloy. The valves are the union-bonnet type. In sizes ¾ through 2 in. the bonnet ring, bonnet and yoke are separate parts; from ¼ to ½ in. these parts are cast in one piece. The joint

OCTOBER, 1948

POWER GENERATION
53 W. Jackson Blvd.
Chicago 4, Illinois

Please have the manufacturers send me without obligation further information on the equipment indicated by the follow- letters:

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Please Print Clearly

Your Name.....

Your Title.....

Your Company Name.....

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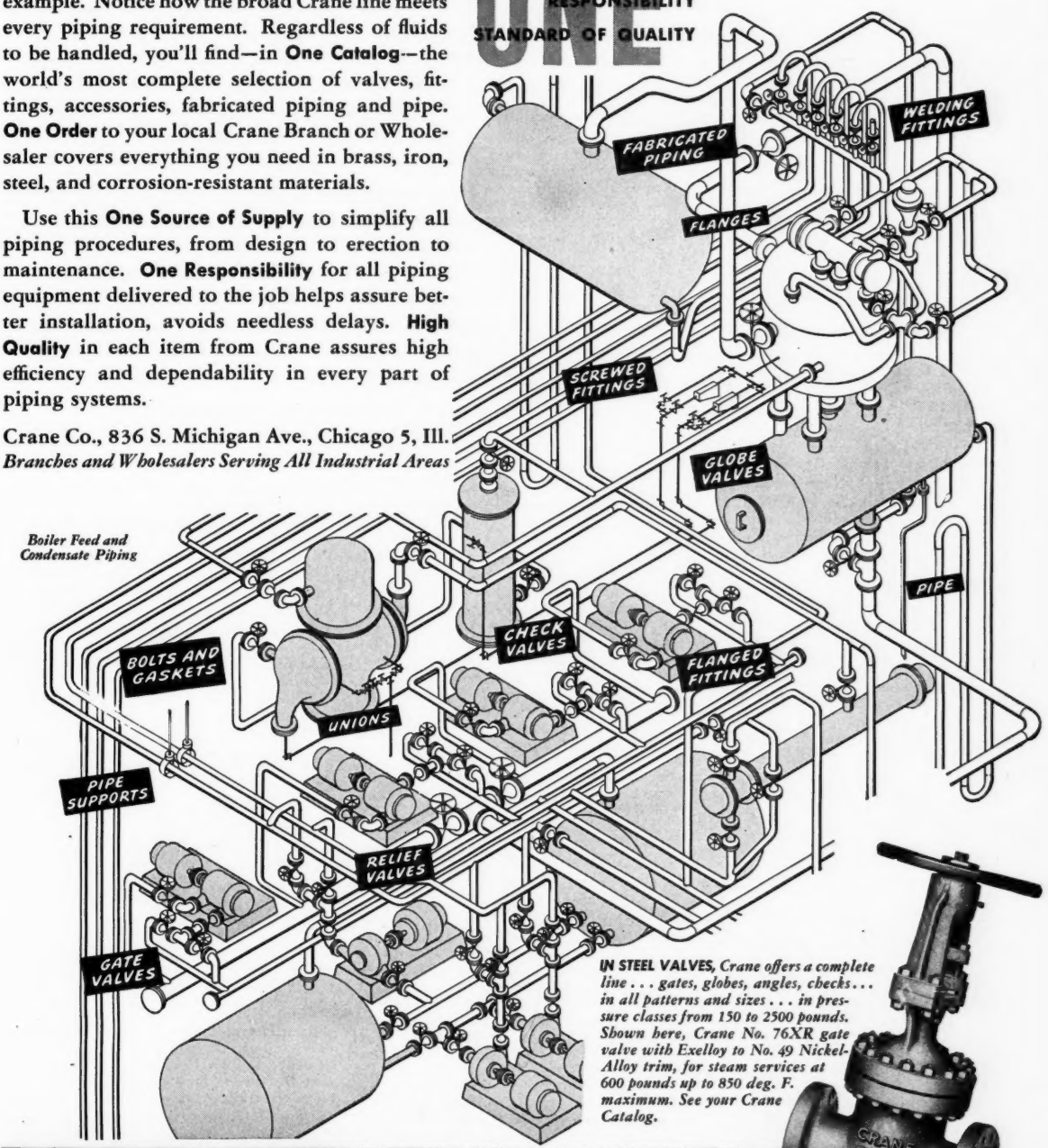
If it's anything in piping...
CRANE has everything you need

Take This Boiler Feed and Condensate System, for example. Notice how the broad Crane line meets every piping requirement. Regardless of fluids to be handled, you'll find—in **One Catalog**—the world's most complete selection of valves, fittings, accessories, fabricated piping and pipe. **One Order** to your local Crane Branch or Wholesaler covers everything you need in brass, iron, steel, and corrosion-resistant materials.

Use this **One Source of Supply** to simplify all piping procedures, from design to erection to maintenance. **One Responsibility** for all piping equipment delivered to the job helps assure better installation, avoids needless delays. **High Quality** in each item from Crane assures high efficiency and dependability in every part of piping systems.

Crane Co., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

ONE
SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY



Boiler Feed and Condensate Piping

IN STEEL VALVES, *Crane offers a complete line . . . gates, globes, angles, checks . . . in all patterns and sizes . . . in pressure classes from 150 to 2500 pounds. Shown here, Crane No. 76XR gate valve with Exelloy to No. 49 Nickel-Alloy trim, for steam services at 600 pounds up to 850 deg. F. maximum. See your Crane Catalog.*

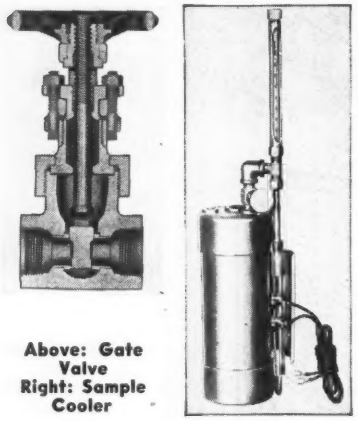
EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM

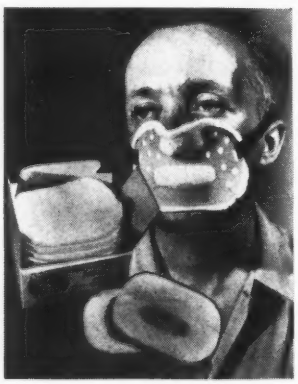
between the body and bonnet is sealed with a soft iron gasket, which is not affected by high temperatures or by any of the fluids for which the valve is recommended. The valve has an outside screw and yoke. Special attention has been given to the design of the stuffing box, which is deep enough on valves over ¾ in. in size to hold six rings of square packing. The gland is held by two T-head bolts fitted into slots in the yoke and can be adjusted easily. Crane Co.



Above: Gate Valve
Right: Sample Cooler

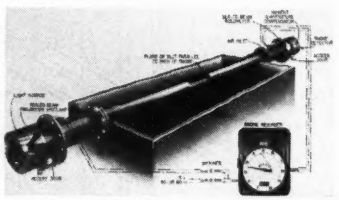
F Compact Sample Cooler. A new compact unit for continuous sampling of low-pressure steam is announced. Consisting of a copper coil within a copper shell, the model SC-9 sample cooler, rated to condense 125 psi saturated steam, runs the cooled sample through a throttling valve, past a thermometer and then through a small flow type conductivity cell, and to waste. A wide variety of solu-bridges and solu-bridge recorders for steam purity measurements are adapted for use with the new sample cooler. Steam sample inlet and cooling water connections are respectively ⅛ and ⅜ in. I.P.S. Overall dimensions are 18 by 4½ in. Industrial Instruments, Inc.

G Protective Masks. G-S protective masks consist of a plastic shield, held in position by an adjustable elastic head band, and replaceable laminated filters of extra thickness. They protect throat, nose and bronchial



tubes from larger particles of non-toxic dusts causing discomfort and susceptibility to infections. Masks weigh less than ½ oz. G-S masks are particularly recommended for use in foundries; cement, lime, gypsum, talc and similar plants; in machine shops, factories, mills, everywhere except when fine silica dust, lead, arsenic and other toxic dusts are present. Price 25 cents each. General Scientific Equipment Co.

H Smoke Density Recorder. A new electronically-operated Smoke Density Recorder measures and records the density of smoke or dust in flues or ducts. The instrument consists of a standard electronic recorder, a Bolometer Type smoke detector and a sealed beam light source. The Bolometer type smoke detector and the sealed beam light source are used as the primary element. They are installed on opposite sides of the smoke passage so that the beam from the light source is directed at the tungsten filament of the Bolometer. The amount of radiation



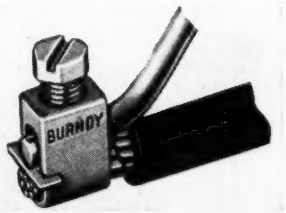
reaching the filament is dependent upon the density of the smoke or dust; and the temperature of the filament is dependent upon the amount of radiation reaching it. The filament temperature is measured by the electronic recorder in terms of smoke density. To insure proper alignment of the Bolometer and light source they are mounted on opposite ends of a 4 in. pipe extending across the entire width of the smoke passage. This pipe is slotted to insure the free passage of smoke into the radiated beam from the light source. A temperature compensating circuit eliminates errors due to high ambient temperatures, and is unaffected by normal voltage variations. The Bolometer is of "sealed beam" construction (similar to the common automobile head lamp) to resist the usual corrosive vapors found in flues. Bailey Meter Co.

J Extreme-Pressure Lubricant. Molykote, a new-type dry lubricant, consists essentially of molydenum disulfide powder. Maker claims that with light rubbing it adheres tenaciously to even the smoothest surfaces. Tests have shown its low friction coefficient and capacity to prevent galling, seizing, or metal-to-metal contact at bearing pressures well over 100,000 psi, and at either high or low sliding velocities. Ten oz will cover 500 sq ft of smooth metal surface with a tenacious, shiny coating. It is equally suitable for high, low, and room temperatures. When used on screw fasteners or press fits, assembly takes place at a smoothly increasing torque or force without jerking. It may be mixed to a paste with SAE 10 motor oil. Available in 10 oz shaker-type cans at $3.00 per can. Alpha Corp.

K Vibratory Bowl Feeders. A method of applying electro-magnetic vibration to a bowl container produces a circular traveling and climbing motion of small pieces, parts, or bulk powders. By having a grooved track ramp up the inside of the wall of the bowl these small pieces can be fed one at a time, in single file, in a predetermined manner to a machine, to packages, for inspection, for counting, for

assembling to other parts and to similar purposes. Speed of feed and starting and stopping of flow can be readily controlled. The size of the piece to be handled, particularly the length, determines the arc of the grooved track, consequently, the size of the bowl. Used as a feeder machine for powders, etc., it will feed down to extremely small quantities and stream size, furnishing its own agitated and vibrated bowl supply hopper. Can be operated from 110, 220 or 440 v, a c current. Syntron Co.

L Service Entrance Connector. Copper and aluminum conductors can now be connected at service entrances by means of a new Buttin. Only one connector type is needed to connect every possible combination of



service entrance wire, copper to copper, copper to aluminum, aluminum to aluminum, and aluminum to copper. The tin-plated copper alloy body makes the Buttin suitable for both aluminum and copper. A pressure bar, also tin-plated, prevents contact of dissimilar metals and distributes the screw pressure. Burndy Engineering Co.

M Thermal Barriers. Two new and improved thermal barrier materials capable of withstanding temperatures as high as 2800 F. have been added to a line of stabond cements, adhesives and allied compounds. The versatile new sealing compounds, known as Stabond FR 8 and FR 10, are obtainable in various consistencies for application by trowel, brush or extrusion gun and will find an application in

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industry virtually wherever a problem of heat resistance or exchange exists.

In a test, an oil tank covered by a ⅛ in. coating of FR 10 withstood a 2,000 F flame blast for 36 min. without damage to the underlying metal. The new compounds are particularly suitable for application as an insulating material to electrical junction boxes, heat exchanger couplings and similar points. They will prove valuable for lagging steam pipes and hot air ducts wherever resistance to vibration as well as heat is a desired characteristic. They may also be used as an abrasion resistant coating for electrical systems. American Latex Products Corp.

N **Offset-Mount Oiler.** A new automatic oiler for solid, wick, or waste-packed bearings, especially designed for installation where space between oil hole and machinery is very limited. Off-center feed spout makes mounting possible where clearance is as little as ¾ in. On the slightest temperature rise, oiler discharges a few drops of oil, feeding stops automatically as oil cools bearing. Operation is constant and positive with filling of always visible reservoir the only attention necessary. This is said to eliminate oil waste, expensive down-time for hand oiling, oil damage to surroundings and finished merchandise. Trico Fuse Mfg. Co.

Above: Offset Mount Oiler

Left: Strip-O-Chart

O **New Strip-O-Chart.** The Strip-O-Chart, designed for attachment to SK rotameters with rigid, cast iron tube frames, provides a convenient, direct flow reading chart and eliminates the need for separate calibration charts. The retaining strip for the chart is made of stainless steel, while the removable scale is reproduced on chart film. The Strip-O-Chart will be made to customers' specifications and will contain the P.O., calibration units and other identifying information. Both the mounting holder and the chart can be shipped immediately after receipt of orders. Complete information on the meter for which the chart is intended should be included with orders. Schutte and Koerting Co.

P **Air Flow Calculator.** Those men who are called upon to calculate final pipe diameters, air volumes, static loss and other air flow figures can save themselves time with this air flow calculator. The calculator is of the nomogram type, arranged circularly and using both sides for calculations. A small portion of the calculator can be used to figure out the size of this company's dust collectors for a specific cfm with either 2 to 1 or 3 to 1 free

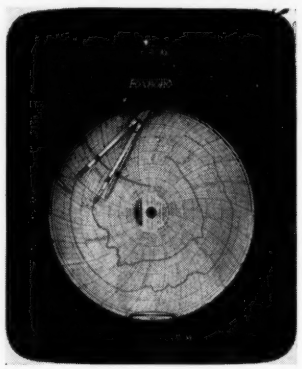
cloth area. This element does not obtrude. The use of both sides and the 6 in. dia of the calculator permits the use of large, clear, easily read scales. Northern Blower Co.

Q **Interchangeable Hub Sheave.** This new sheave enables various diameter rims to be mounted on the same hub, and/or, hubs of different bore to be mounted on the same size rim. Heat treated socket head screws, held securely by lock washers, attach hub and rim together through template drilled holes in the rim web which assures complete interchangeability and quick mounting without special tools. Smaller diameter sheaves utilize fillister head screws. The hubs are bored to shaft size and keyseated. There are no bushings. Perfect fit and concentricity of bore with rim diameter is assured

by machining shoulders of the hub and the web face. Sheave rims are made from light weight, stress free, semi-steel castings which are machined and balanced carefully to assure maximum belt life. These sheaves are now available from stock for drives serving ⅓ to 10 hp requirements. They may be obtained in one, two and three grooves for A section belts, also in combination grooves for A or B section belts in sizes from 2.2 in. PD to 18.4 in. PD. Transmission Machinery Corp.

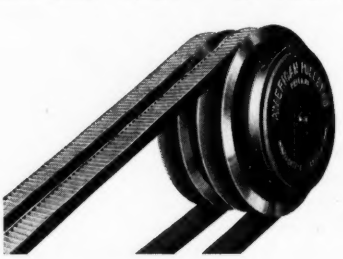
R **Repair Alloy.** A new low temperature bronze base permanent repair alloy that meets many industrial repair and maintenance applications is now available. Lo-Temp, the permanent repair alloy, handles like putty at only 300 F and fuses with the metal surface under repair. Manufacturer states finished repair can be machined, filed, drilled and tapped, and that the low temperature required will not cause crystallization or distortion. It is claimed that Lo-Temp will not corrode, run, crumble, shrink, or dry out, and that it works with any metal except aluminum or its alloys. An ordinary gasoline torch and a putty knife is the only equipment necessary to make permanent repair. Lo-Temp is not intended as a substitute for welding but meets the need for a strong metal permanent repair alloy that can be machined and handled at a low temperature. John Hewson Co.

S **Auto Selector Controller.** With the announcement of the Auto-Selector Controller, an addition is made to a line of industrial control instruments. This new instrument controls, selectively, from either of two related variables, by positioning a single valve, damper, or other operator. This selection is determined by the variable having the greater tendency to exceed its pre-set limit; and the transfer of control is made smoothly, instantly, and automatically. The Auto-Selector not only does the work which previously



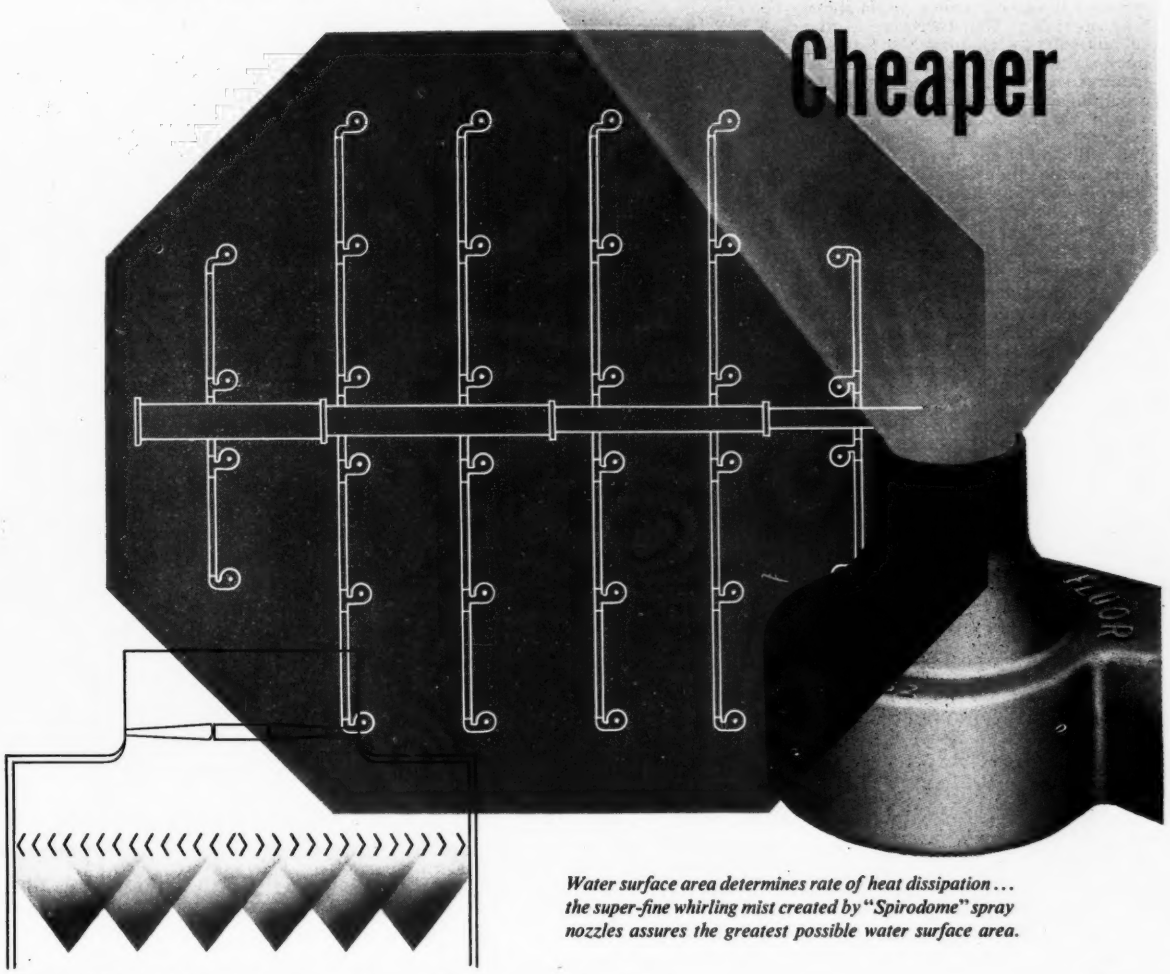
required two controllers, but has an added important advantage in that it may incorporate the automatic reset function in the control of either or both variables. The design of the instrument embodies two measuring systems and two inter-connected Model 40 control mechanisms. Control action of both mechanisms may be on-off, proportional, proportional with derivative, proportional with reset, proportional with reset and derivative or any combination of these. Foxboro Co.

T **Adjustable Sheave.** A new wide range, adjustable diameter drive is claimed to be the first sheave that provides permanent adjustability. New construction feature is the rubber-



lagged hub. Bonded to the steel hub of the sheave, the rubber section eliminates freezing, and cuts out noise, pounding and vibration. Each individ-

THOROUGH AIR-WATER MIXTURE = Colder Water Cheaper



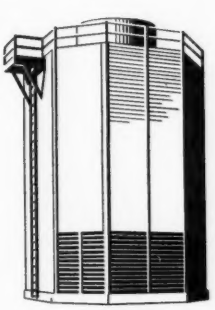
Water surface area determines rate of heat dissipation... the super-fine whirling mist created by "Spirodome" spray nozzles assures the greatest possible water surface area.

Cheaper? Yes, and here's why: The upspray distributing system in the Fluor "Counterflo" induced draft cooling tower, which incorporates the patented "Spirodome" Spray Nozzles, adds 8 or 9 feet of *unseen* cooling tower height. Here's how:

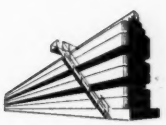
Water is sprayed 6 to 8 feet up into a spray chamber, where the drops are broken up into minute particles, and where the great heat load is flashed off before the drops even reach the first deck. Therefore the function of the decking is not to release the great bulk of the heat, but rather to cool the water to as close to wet bulb temperature as possible.

This system is a "must" where hot water is to be cooled, since the upper portion of the tower is at least twice as effective as the same tower with the usual flume and splash plate system.

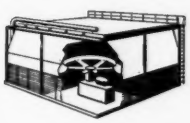
Yes...Fifty years' experience proves Fluor Cooling Towers will, year in and year out, deliver colder water cheaper.



Fluor "Counterflo" induced draft cooling towers, prefabricated in mass production, are available in multiple or single units in any required size or height.



Fluor areator atmospheric cooling towers are recommended where conditions make this type most practical.



The Fluor Fin-Fan cooling unit has a wide, economical range of utility throughout industry.

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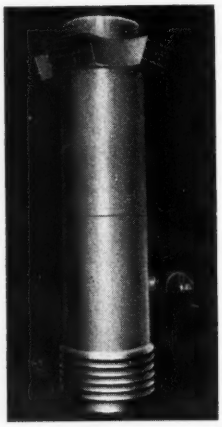
ual flange, as well as the entire assembly, is dynamically balanced. The adjusting mechanism provides a positive means of shifting all flanges simultaneously. A single locking screw prevents flange movement while sheave is in operation. Non-corrosive features of adjusting mechanism are stainless steel screws connected with specially constructed gears, enclosed in a dust-proof housing. These sheaves are available in two and three grooves with pitch diameter variation of 5.25 to 10.0 in. The adjustment for speed variation is made while the drive is stationary. Sheaves use multiple R section V-belts and will handle loads up to 15 hp. American Pulley Co.

U Solenoid Valve. A new 4-way solenoid valve is announced. The small, compact unit is of the balanced spool type, controlled by a built-in solenoid pilot valve. Design permits flexibility in piping arrangements, lines may be connected to bottom, sides or a combination of both, as desired. Three point mounting pads are provided to prevent distortion of parts. The valve is adaptable to straight line piping, with valve capacity equal to rated pipe

size. Valves and manifolds are interchangeable and the valve proper may be removed from manifold without disconnecting pipe lines. A feature is the facility for removing and replacing solenoids without severing wiring connections if a cord with pin plugs is used. The spool and sleeve assembly also may easily be replaced by simply removing end caps without moving valve out of position. Hanna Engineering Corp.

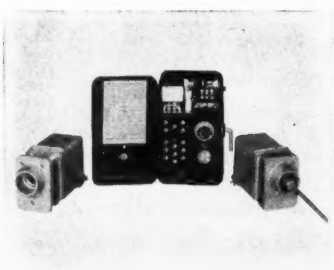
V Direct Fired Unit Heater. The thermobloc is a unit delivering 550,000 btu's without excessive air currents and without expensive and complicated air ducts throughout the plant. With No. 3 type fuel oil or with gas the Thermobloc operates at 80 to 85 per cent efficiency. The floor space required for each unit is of 30 in. dia to permit the unit being installed in locations which will not interfere with the operating area. Thermobloc is completely automatic and requires no attendant. It is shipped ready for operation after a fuel, electrical and exhaust gas connection. Accurate control of heated air quantity and temperature permits the use of one or several standard units for drying purposes as well as ventilating. During the summer months the air fan can be operated for



withdrawing the cold air at the floor level and blowing it to the normal working level. Thermobloc Div., Prat-Daniel Corp.

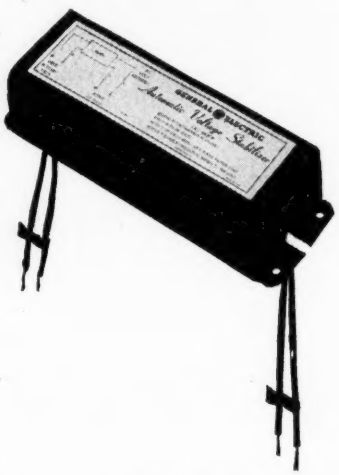
W Small Tachometer. A completely new, rugged, small-size, low cost electric tachometer, designed for continuous operation, is announced. Measuring only 2¾ by 5⅜ in. this small unit broadens the field of applications for tachometers to provide an indication of speed and production. Housed in a cast bronze case, the new tachometer will operate in any position through a wide range of temperatures. The unit is equipped with a large driving shaft. Grease-packed ball bearings assure accuracy and long life. Various shaft arrangements are available. A suitable assortment of indicating meters is available. Electric Tachometer Corp.

X Flame Failure Safeguards. To meet the need for efficient flame failure safeguards and controls on gas-oil conversion burners, Fireye Systems FF-2 and FF-6, are available. System FF-2 is used on oil burners which use gas as an alternate fuel. The system consists of photoelectric scanner Type 45PH5, electronic flame rod Type 45JP1, and programming control Type 24PJ8. When the system is used on oil, the photoelectric scanner monitors the main oil flame providing instantaneous safety shutdown on flame failure. The programming control programs the sequences of ignition and fuel systems, and the electronic rod monitors the pilot gas flame, preventing the main fuel valve from opening until pilot flame is properly established.



When the system is converted to gas, the electronic rod monitors the continuous gas pilot flame and the programming control programs fuel and ignition systems. A simple switching means is all that is required for the change-over from oil to gas. System FF-6 is used on gas burners which use light oil as an alternate fuel. The system includes electronic rod Type 45JQ1 and control Type 24QJ5. The electronic rod monitors the continuous gas pilot, providing through the control instantaneous safety shutdown of main flame on pilot flame failure. Monitoring operations on gas and light oil are identical and no wiring changes are required on change-over. Combustion Control Corp.

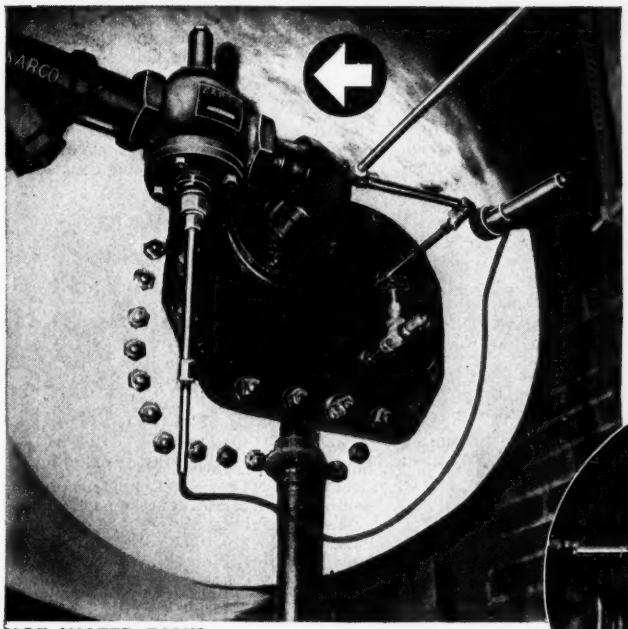
Y Automatic Voltage Stabilizers. Three new voltage stabilizer units have been added to a standard automatic voltage stabilizer line. The new units are 115 v, 60 cycle designs in 15, 25 and 50 va ratings. They provide a steady output of 115 v (+ 1 per cent for fixed, unity power factor loads) with input voltages ranging from 95 to 130 v. Low case height and small size make them particularly suitable for



shallow depth installations. Other features include totally insulated construction and universal type leads. The latter feature makes these units adaptable to a variety of wiring and mounting arrangements. Maintenance requirements are negligible since there are no moving parts in the stabilizer and operation is automatic. General Electric Co.

Z Photoelectric Counter. Photoelectric counter Type 20AP5 is a general purpose unit for installation on any conveyor system or automatic machine. It is designed for counting in the brewery and dairy fields; for loading chutes and conveyors; for painted, hot objects, and small objects; for textile and leather piece goods; and selective by height and length. The light source supplied with the photoelectric counting equipment has an adjustable lens system which permits narrowing down the light beam for counting very small objects.

Counter Type 20AP5 is packaged complete including light source, photoelectric control, and electric counter. Simplicity of installation is featured. The light source and electric counter



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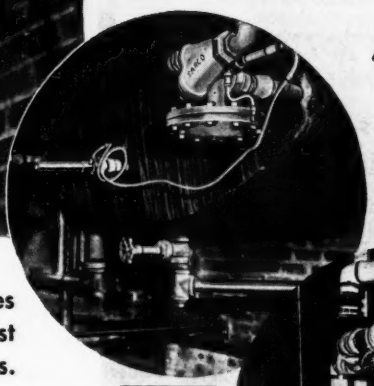
It's not a luxury to have all hot water services Sarco Temperature Controlled. In fact, on most jobs, the controls pay for themselves in four ways.

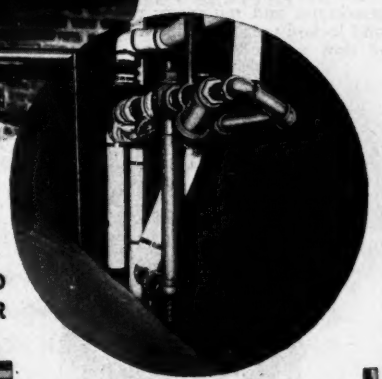
1. Automatic control prevents overheating — fuel is saved
2. "Never too hot, never too cold," increases quality and quantity of output in heat processing
3. Blending of water for showers and wash basins increases hot water storage capacity
4. Everything works, 24 hours a day, without shut-downs or complaints.

In a factory, a service tank was controlled for twenty-four years at a cent a day. A mine saved hundreds of dollars by installing Sarco Blenders for showers, and dish washing.

What would Sarco Temperature Controls save in your plant? Why not ask the Sarco Man near you?



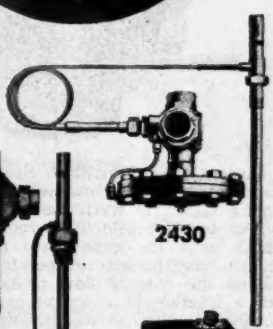
STORAGE TANK



BLENDED WATER

MB BLENDER

TR 21



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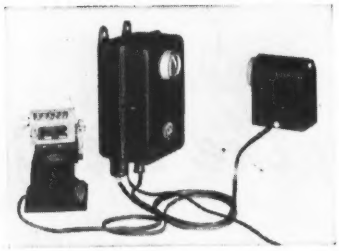
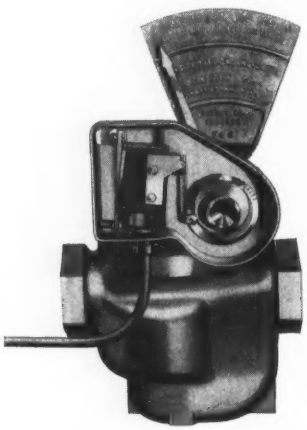


are supplied with cords and plugs which attach to the photoelectric control. This has a line cord for plugging into any lighting circuit. The entire counter can therefore be installed quickly and without the help of an electrician.

The same counter will count bottles or cases, light objects or heavy objects. One or more may be located anywhere in the plant, remote from the location where the count is being made. Photoswitch, Inc.

AA Automatic Alarm System. This new alarm system for flow indicators consists of selectivity controls, a sensitive microswitch and electric wires leading to an alarm. The pointers of the controls are set at the desired maximum and minimum rates of flow and locked with a knob. When the rate of flow varies beyond that set by the



pointers, the microswitch closes contact and sets off an alarm, either a light or noise signal, to warn the operator.

An accurate selectivity range is possible with the new alarm unit. The alarm may be set to operate a signal when the rate of flow exceeds limits of a fraction of a gallon per minute, or it will operate at the widest range limits. Despite the addition of the alarm system, visual reading of the dial is retained. Henszey Co.

BB Corrosion Resisting Coating. A new coating which is said to resist corrosion is offered for wood tanks, floors, racks, tables, fume hoods, and other equipment made of wood. Maker claims that joints made with Carbo-Kote are stronger than the wood itself. It is said to resist heat up to 325 F indefinitely. It resists most acids, alkalis, solvents, and mixtures. The exceptions are nitric acid and sulfuric acid of more than 45 per cent concentration. Surface is flexible up to 10 to 15 per cent. Carbo-Kote is intended primarily for wood but works equally well on rubber, carbon, and fibreglass. With a special primer it may be used on steel. Carboline Co.

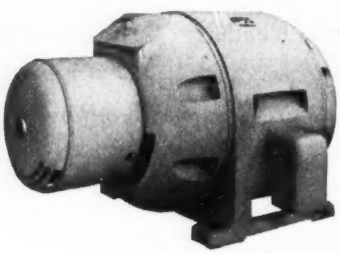
CC Class B Iron Valve. This new Class B Iron Valve, Type B-9468, is rated at 50 lb. It is designed for rugged hydraulic service and equipped with the patented R-S rubber spool, Type B-8934. The rubber spool combined with the wedge-type closure of

the angular seating disc provides positive shut-off for thousands of full-open-to-full closed cycles. Despite the conservative rating as a 50 lb valve the new unit will give bubble-tight shut-off up to 80 psi, and commercially tight shut-off at 100 psi. R-S Products Corp.

DD Solderless Wiring Hand Tool. Wiring applications requiring installations of solderless terminals by manually operated tools can make use of a new line of hand tools that eliminate the possibility of faulty electrical connections resulting from operator fatigue or carelessness. Certi-Crimp tools incorporate a simple, effective device that prevents re-opening of the tool for admission of a new terminal until it has been completely closed for a perfect crimp on a previous terminal.

Operation of the tool is unaffected by the Certi-Crimp feature which is constructed so that it cannot be tampered with nor changed without obvious damage. Aircraft-Marine Products, Inc.

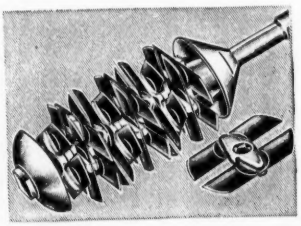
EE Synchronous Motors and Generators. A new line of general purpose, Tri-Clad, high speed synchronous motors and generators in 900 series frame sizes, has been announced. The



new motors are available in standard ratings from 20 hp to 1,000 hp at 60 cycle speeds of 514 to 1800 rpm, in either two-phase or three-phase types. Generators are available in ratings from 12½ to 1250 kva.

Of drip proof construction, the motors incorporate the usual Tri-Clad features. Direct-connected and belt-driven exciters are available for all ratings. Large Motors and Generators Div., General Electric Co.

FF Flue Shaver. The Thor Flue Shaver is said to remove hard carbon and scale right down to the metal and leaves the flues clean and like new. It has an exclusive construc-



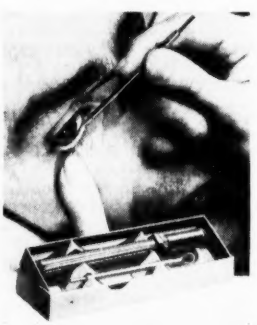
tion of 11 reinforced Swedish spring steel blades, with 44 sharp cutting edges, mounted on a heavy octagon steel shaft.

The manufacturer offers a 30 day free trial. Sizes: 2½, 3, 3½ or 4 in. OD flues. Goedert Flue Shaver Co.

GG Spring Type Battery Terminal. Introduced is a new spring type battery terminal for use wherever storage batteries are used. It is claimed that use of this terminal eliminates the chance of loosening battery post on removal, avoids breaking top of battery cell, makes it easy to remove terminal for inspection or cleaning. Installation of the terminal to cable is simple as the nut is split nearly in two. To fit the cable it is only necessary to split the nut completely and insert the cable following by screwing the terminal up on the nut. Terminal is made of aluminum alloy. Nut and pressure spring are cadmium plated to resist battery acid. James A. Stanley Co.

HH Eye Sweep. Wherever industrial accidents occur, and especially where workers are exposed to flying metallic fragments, filings or other foreign metal substances subject to magnetic attraction, the Eye Sweep is an indispensable unit of first aid.

One end is fitted with a magnet for removing steel splinters, while the other



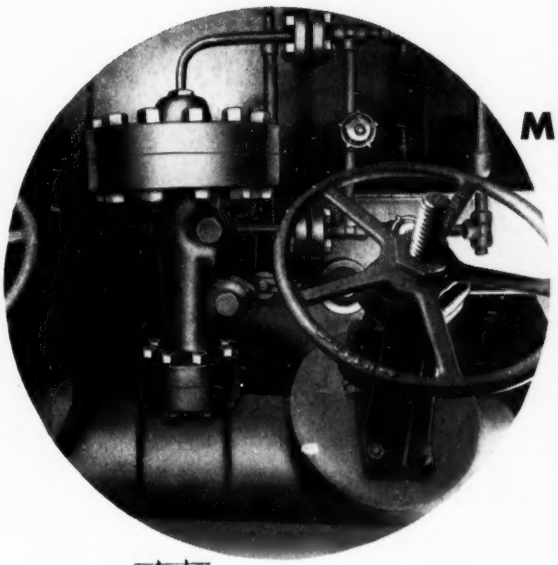
is fitted with a flexible loop for removing cinders, dust and other particles. Sterilization of the instrument will not diminish the magnetic qualities nor affect the loop. A hard rubber carrying case is provided with each Sweep. Price, $2.50. General Scientific Equipment. Co.

WATER GAS PLANT INSTALLS

28th COPES FEED WATER REGULATOR

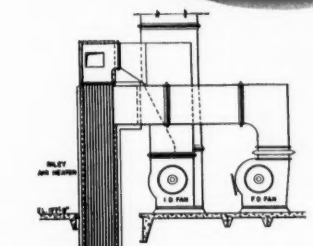
for

MOST UNUSUAL SERVICE

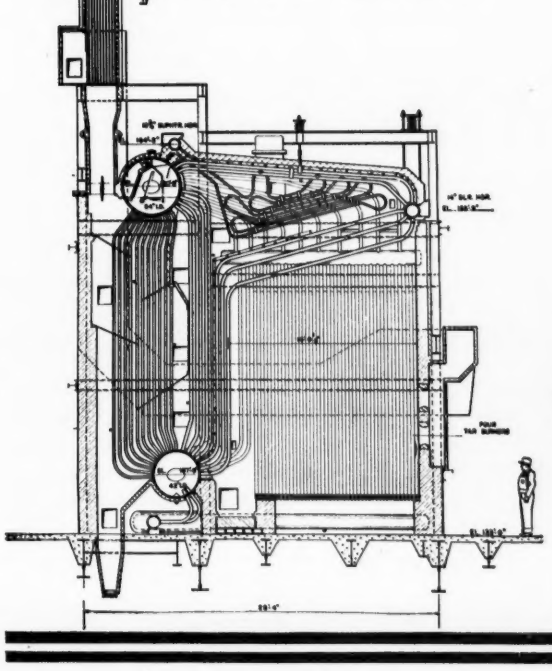


The twenty-eighth COPES Feed Water Regulator installed by a well-known gas company was for one of the first water-gas plant boilers ever to operate at 625-psi and 700-F. A two-element Flowmatic Type D-O, it gave excellent control of both feed flow and water level for the tar-fired Riley Type RP Steam Generator. Another Flowmatic has since been installed on a second 625-psi boiler.

This company had installed its first COPES in 1927 on a 175-psi, 500-F direct-fired boiler. Now five such boilers are equipped. In addition, every waste-heat boiler—on water-gas sets and on gas producers—is COPES-protected. Thirty-five COPES Regulators are in service.



BULLETIN 483 tells the story of this Flowmatic on the Riley unit shown below, and gives the history of COPES in this important gas works. Write for it.



NORTHERN EQUIPMENT COMPANY

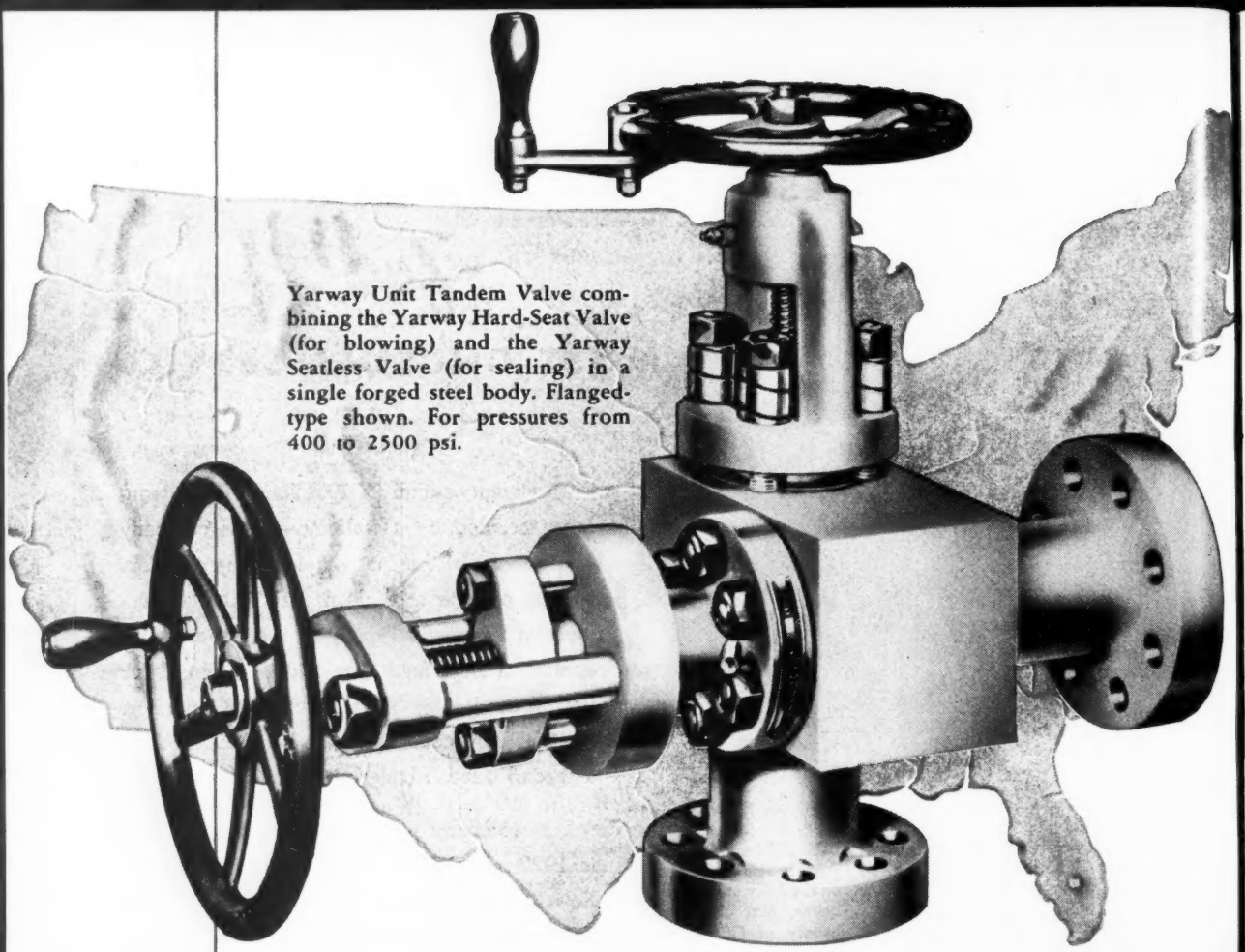
1082 GROVE DRIVE, ERIE, PENNSYLVANIA

BRANCH PLANTS in Canada, England, France, Austria, Italy. ***Representatives Everywhere***

COPES

Headquarters for . . .

Boiler Feed Water Control . . . Excess or Constant Pressure Control, Steam or Water . . . Liquid Level Control . . . Balanced Valves . . . Desuperheaters . . . Boiler Steam Temperature Control . . . Hi-Low Water Alarms.



Yarway Unit Tandem Valve combining the Yarway Hard-Seat Valve (for blowing) and the Yarway Seatless Valve (for sealing) in a single forged steel body. Flanged-type shown. For pressures from 400 to 2500 psi.

NORTH

WEST EAST

SOUTH

it's YARWAY 4 to 1

From every corner of the country comes the same story—four out of every five high pressure boiler plants are equipped with Yarway Unit Tandem Blow-Off Valves.

Each day's orders add to the evidence. From Ohio . . . 17 new Yarways, making a total of 746 purchased by this large utility over the last 35 years. From California . . . 10 new Yarway Unit Tandems for one company, 9 for another. Texas sends an order of 5 . . . 3 for one new municipal plant, 2 for another. Northern New York wants 7 for new boilers in a well-known utility. And so it goes.

Why this overwhelming preference?

Proved dependable performance, due to outstanding design, sound engineering and careful manufacture . . . plus constant research, leading to mechanical and metallurgical advancements that keep Yarway Valves ahead of changing service requirements.

For latest information on Yarway Unit Tandem Blow-Off Valves, write for Yarway Bulletin B-432.

YARNALL-WARING COMPANY
114 Mermaid Avenue, Philadelphia 18, Pa.

YARWAY BLOW-OFF VALVES

WHAT LEADERS SAY

Engineered Specifications Aid Industry, Business and Government

By E. W. ELY,
Commodity Standards Division, National Bureau of Standards

THE PURCHASING AGENT who wishes to make use of a scientific approach to his problems will find that his task has been greatly simplified by the National Bureau of Standards. Use of dependable specifications—the only logical way to achieve economy in purchasing—has been facilitated through the Bureau's compilation of all the standards and specifications in general use for commodities produced or purchased in this country. The result, a comprehensive reference book of unusual simplicity and clarity (the National Directory of Commodity Specifications), briefs, catalogs, and indexes the information needed in buying all types of products.

A specification is a concise, definite, and complete statement of what the buyer requires from the seller. It includes limiting values for the properties necessary to meet the required service, with proper tolerances.

Large-volume purchases presuppose definite specifications so that the bidder may know definitely just what he will be required to supply. The only alternative to the system of purchase by competitive bids on specifications is purchase on sample. The latter method implies that each bidder's product must be considered independently, and it is often a very difficult matter to decide between different combinations of quality and price. A well-written specification, on the other hand, enables bidders to know exactly what is desired or required and also what procedure the purchaser may follow to satisfy himself that the materials submitted are or are not satisfactory.

A satisfactory specification is not easily prepared. The really essential qualities of a product cannot be determined from mere inspection. Laboratory research is necessary, and this sometimes involves months or even years of work. The method used in testing must likewise be developed with great care. Accelerated tests are necessary in many instances, creating one of the most difficult phases of commodity testing. Experience alone can determine whether an accelerated service test carried out in a few days in the laboratory actually represents with sufficient fidelity of years of exposure to sunlight and rain, or the ravages of wear.

The Federal Government is the largest single purchaser of consumer goods in this country. Obviously the purchases of an organization of this size can be made to greater advantage under carefully prepared spe-

(Continued on page 106)

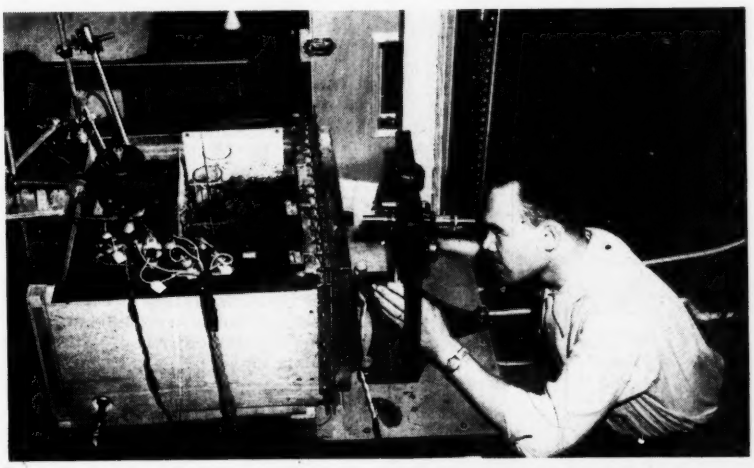


Fig. 1. (Above). Apparatus designed at the Bureau for determination of the molecular weight of a plastic substance by measurement of the osmotic pressure it produces in solution

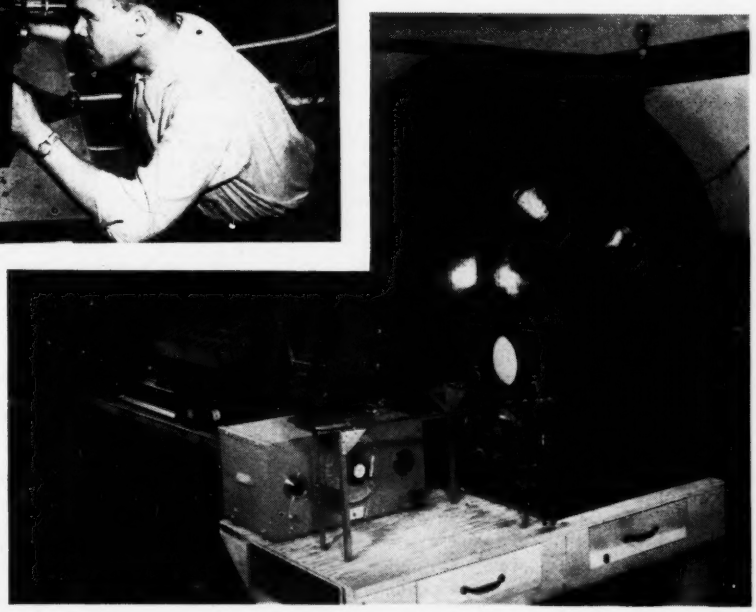


Fig. 2. (Right). Apparatus developed at the National Bureau of Standards for investigating the characteristics of photographic flash lamps as a basis for formulation of a Federal Specification. The lamp under study is flashed within the 60-in. integrating sphere (upper right), which so thoroughly diffuses the emitted light that the total flux may be determined at any selected spot on the sphere. A phototube placed at the diffusing window of the sphere (extreme right) is connected to the cathode-ray oscilloscope

New Power Plant for B. F. Nelson

Modernization program started before the war now nearing completion. Old 150 lb boilers replaced by new combination coal and gas fired 450 lb units. Boiler plant went into operation in March. Turbine room now under construction will contain one 3000 kw and one 750 kw turbine generator, the small unit to carry the week-end load

By **J. H. PEEBLES**, Chief Engineer, B. F. Nelson Mfg. Co.
and **H. P. HARRIS**, Chief Engineer, Frederick L. Smith

THE B. F. NELSON Manufacturing Co., Minneapolis, Minn., is celebrating its 80th anniversary this year. It began as a sawmill in the early days when lumbering still flourished as a great industry in Minnesota. Later, it went into the manufacture of strawboard and then into the production of felt and boxboard. Today, it not only manufactures boxboard for other factories, but also makes boxes, roofing dry felt and asphalt roofing. The latter is one of the major parts of its overall activities. Mill facilities today include a board mill, felt mill, roofing mill, asphalt felt saturator, box factory and print shop.

As in all paper plants, power has been an element of major importance in the operation of the plant. In the early years of the company's history this power was supplied by steam engines, belted direct to the paper machines. In recent years, many of the machines were electrified, electric power being purchased from the Northern States Power Co.

Around 1940, however, plans were made to abolish all of the old direct steam drives and to build a new power plant which would not only supply all the steam and hot water needed in the manufacturing processes but also all of the electric power required. Accordingly, Frederick L. Smith, consulting engineer of New York, was retained to make studies and eventually to design a power plant that would meet all power needs efficiently and reliably.

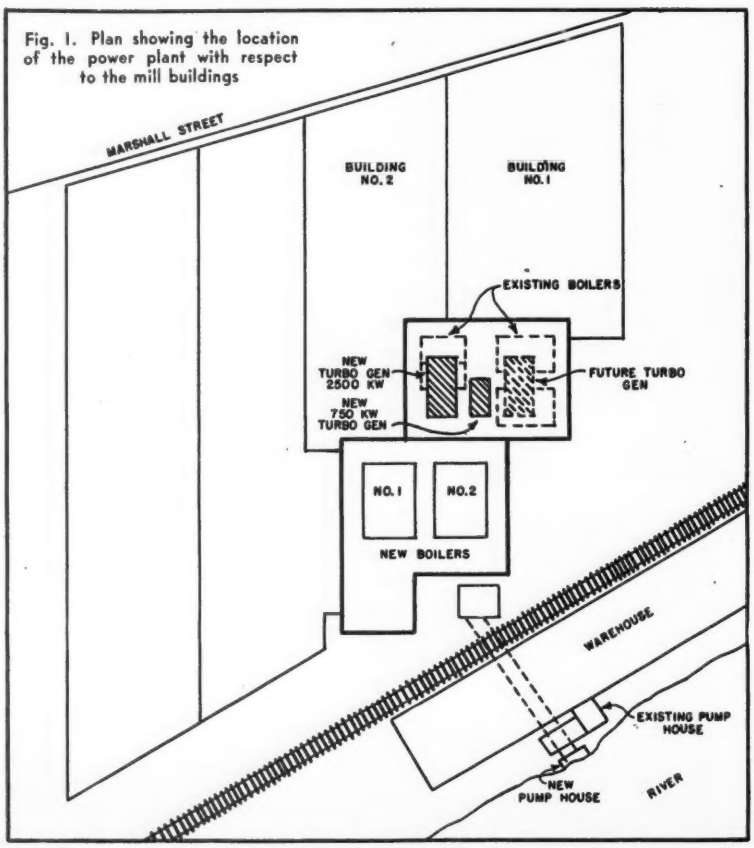


Fig. 1. Plan showing the location of the power plant with respect to the mill buildings

Construction of New Plant Delayed by War

The war, however, halted this modernization program so, during the war years, despite increased production, the existing power facilities carried on.

With the end of the war, however, plans to modernize the power facilities were resumed and construction on a new boiler house was begun, early in 1947. At that time, there were four Babcock & Wilcox Stirling boilers, two of 400 hp and two of 500 hp. The two 500 hp units were fired with Strong-Scott unit pulverizers while the two 400 hp boilers were fired with Detroit C-D single retort stokers.

Power units at that time consisted of one twin Corliss 30 by 48 in. driving the beater rooms and Jordans, one twin Chandler and Taylor engine, 14 by 16 in. cyls, driving the felt drier, one Brownell, twin, 12 by 14 in. unit driving board mill driers and one Chandler, single engine driving the felt mill wet end.

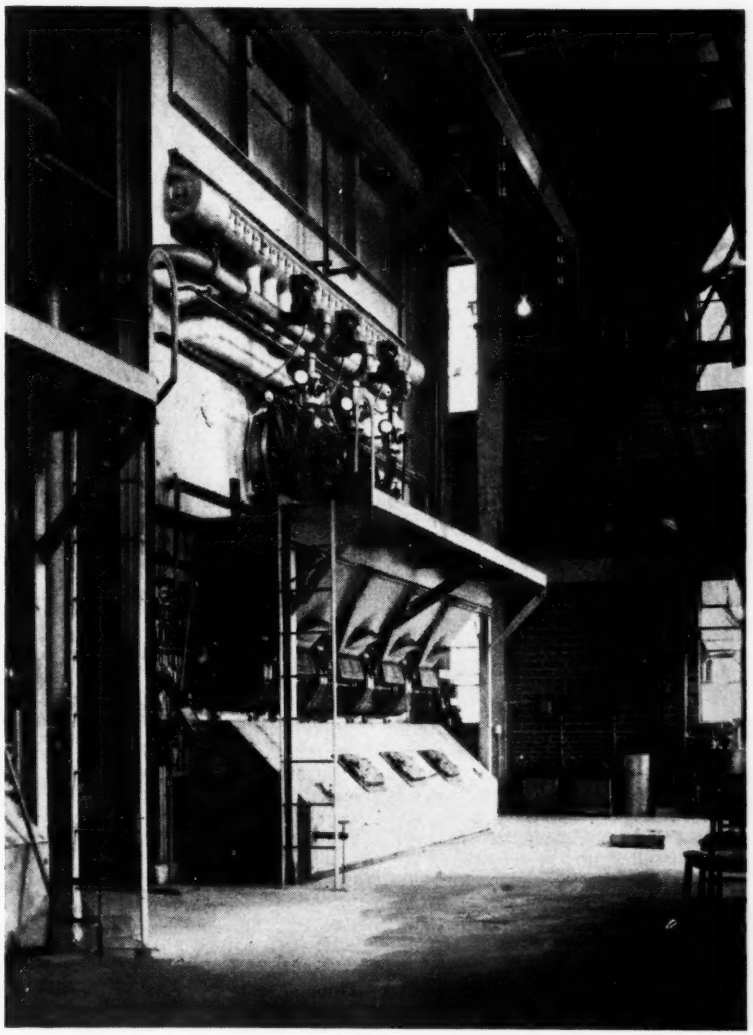
The location of the new power plant with respect to the existing boiler house is shown in Fig. 1. The new boiler house was built adjacent to the old boiler house. Now that this new boiler plant is in operation, the old boilers, together with the building in which they were housed, have been removed to provide space for the turbine room now under construction. Immediate plans involve the installation of two turbine-generator units, one of 3000-kw capacity and the other 750-kw capacity. As shown in Fig. 1, future plans call for the installation of another turbine-generator, the size of which will depend upon future power requirements.

At present, a certain amount of electric power is purchased but when the new turbines are installed, all power needed by the mill will be generated in this power plant.

The new boiler house went into operation early in March of this year. This, as shown by the accom-

Mfg. Company at Minneapolis

Fig. 2. A general view on the operating floor in the new boiler room showing one of the two 400 psi boilers. Note the three combination gas and oil burners installed above the spreader stoker



panying photographs, is a modern, brick and steel structure with two self-supporting steel stacks mounted on the structural steel framework of the buliding. It is a well lighted, roomy building, with ample clearances for convenient access to all equipment.

Boilers Burn Coal, Gas or Oil

The new boiler plant contains two 85,000 lb per hr Wm. Bros. boilers, built for a working pressure of 450 psi and fired both by Bros Superspred Travlgrate Stokers and Coppus combination gas and oil burners. Natural gas is used as fuel whenever it is available. At other times coal is used, alone or in combination with gas.

The general arrangement of the plant is shown in the accompanying drawings. Figure 11 is a cross-section of one of the boilers. Each of these units has 9862 sq ft of heating surface, a grate area of 230 sq ft and a furnace volume of 4400 cu ft. The boilers are four-drum units with the superheater installed at the top of the furnace between the front and middle drums.

As shown in the photograph and drawing, three Coppus combination gas and oil burners are installed in front furnace wall, directly above the stoker. This combination of spreader stoker and gas and oil burners provides an extremely flexible arrangement making it possible to switch to gas or oil or back to coal in a matter of minutes. The hydraulic powered stokers are subject to very fine control.

The furnace is water-cooled, the front wall being a 9 in. Detrick wall, with 2 in. block insulation, 1 in. of cement, enclosed in a No. 10 gage steel casing. The chain grate travels toward the front of the boiler discharging into a 390 cu ft ash hopper as shown. Ash is removed through three 24 by 36 in. Beaumont-Birch ash gates.

All Steam Driven Auxiliaries Operate at 400 psi

The two forced draft fans, one for each boiler, are located on the basement floor level directly underneath the stokers. These are Clarage Fan Co. fans, with dual drives, a 25 hp Elliott steam turbine at one end of the shaft and a 30/7.5 hp 1175/536 rpm General Electric motor at the other. The turbine operates directly from the 400 psi steam line and exhausts into a 20 psi low pressure line to the feedwater heater and softener.

The boilers are provided with 500 psi, 3360 sq ft Foster-Wheeler economizers. Installed at the rear of the boilers the economizers discharge gas directly into the induced-draft fans on the top floor of the boiler house. The induced draft fans, one for each boiler, are Buffalo Forge Co. units, also driven on one side by a 100 hp, 400 psi, 20 psi exhaust Elliott steam turbine through a 4401/875 rpm Elliott reduction gear, and on the other side by a 100 hp, 1180 rpm totally enclosed, fan-cooled, General Electric Co. wound rotor induction motor. The fans are equipped with Buffalo "Super Limit-Load" control. The wound rotor induction motors are controlled by General Electric resistance type controllers installed in conjunction with Square D single throw diseonnect switches.

Each induced draft fan discharges into a steel stack installed on the building structure.

The boilers are equipped with Diamond Power Specialty Air-Puff automatic soot blowers, Copes 2 element Flowmatic feedwater regulators, Lunkenheimer non-return stop valves, and Reliance Eye-Hye water gages. Photoswitch photoelectric smoke indicators (Densometers) indicate the smoke conditions in each stack.

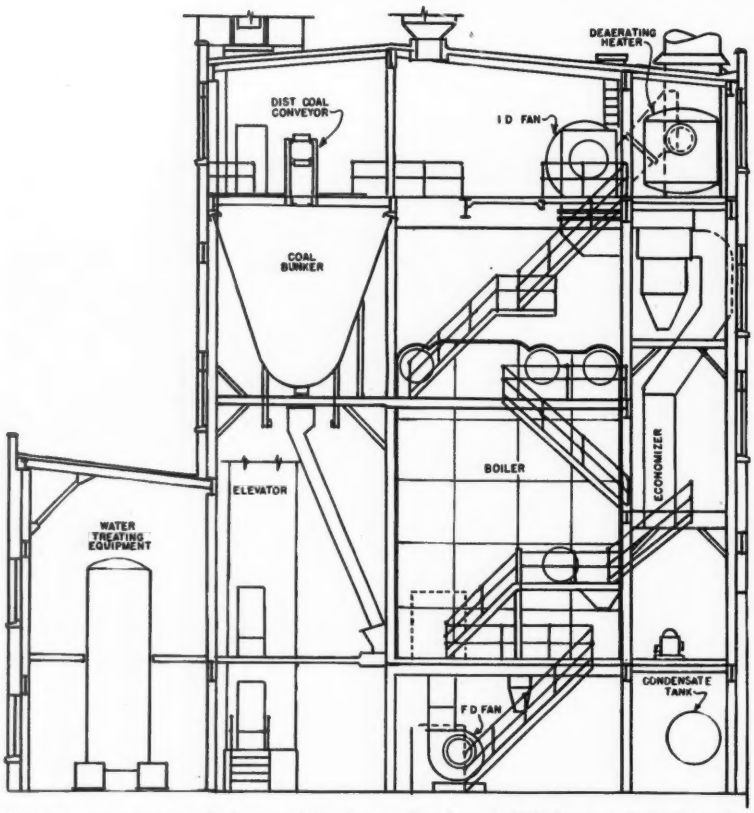


Fig. 3. A cross section of the new boiler house. The forced draft fans are located in the basement. The induced draft fans together with the deaerating feedwater heater are located on the upper floor

Coal is delivered to the plant by railroad cars, into a track hopper. A short flight conveyor carries the coal from the track hopper to the lower end of a vertical bucket elevator installed up the outside of the building. At the top of this elevator another short horizontal flight conveyor delivers the coal to a distributing flight conveyor above the boiler room coal bunkers. The latter extend the length of the boiler room, coal being distributed to the stoker hoppers by a weigh larry equipped with a Fairbanks registering beam scale. All coal handling equipment is Jeffrey. Ash from the stoker ash hoppers in the basement is carried to an outdoor ash storage tank by a Jeffrey Mfg. Co. ash hoist.

Boiler Feedwater

Boiler feedwater is treated in a Worthington Hot Process softener, using lime and soda ash with the addition of phosphate. The latter is fed by means of a Proportioneers, "ad-just-o-feeder," installed on the induced draft fan floor at the top of the boiler house. Accurate control of the boiler feedwater treatment is obtained by frequent, periodic tests made in the chemical laboratory which forms part of the boiler house. Phosphate tests are made with the Color Comparator.[1]

Returns from the mill are collected in a condensate tank after passing through filters for oil removal; this water together with treated raw water is pumped to the 170,000 lb per hr Worthington deaerating feedwater heater on the induced draft fan floor. From the deaerator the water is delivered by gravity to two Ingersoll-Rand boiler feed pump. These pumps are rated at 300 gpm, 1150 ft head and are driven by both a 125 hp Terry turbine and a 125 hp Allis-Chalmers induction motor.

The general steam and water piping system is shown in Fig. 14. It will be noted that all essential auxiliaries are dual driven by both motors and turbines. This not only makes possible flexibility in maintaining efficient heat balance but also facilitates in starting the boiler plant in case of emergency shut-down.

The boilers are operated by means of the Bailey system of automatic combustion control from a control board on the operating floor in front

[1] See, How to Use Color Control Tests for Boiler Feedwater, by F. R. McCrumb, May 1948, page 60.

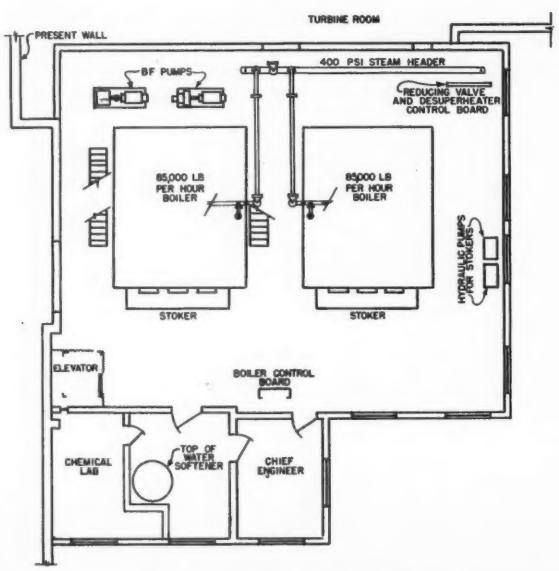


Fig. 4. Plan of the operating floor

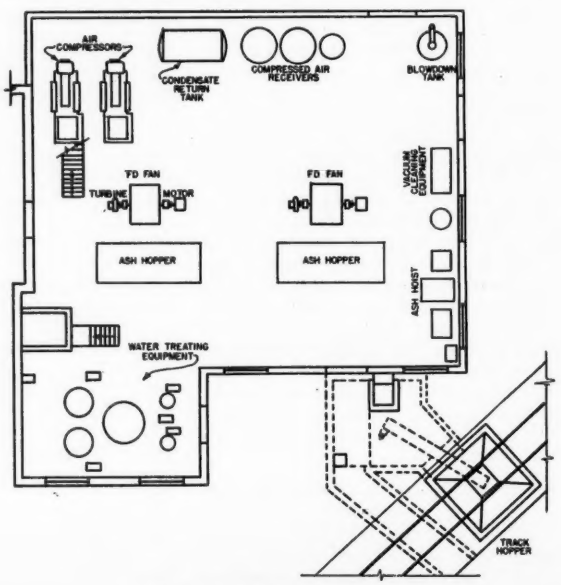


Fig. 5. Plan of the basement floor

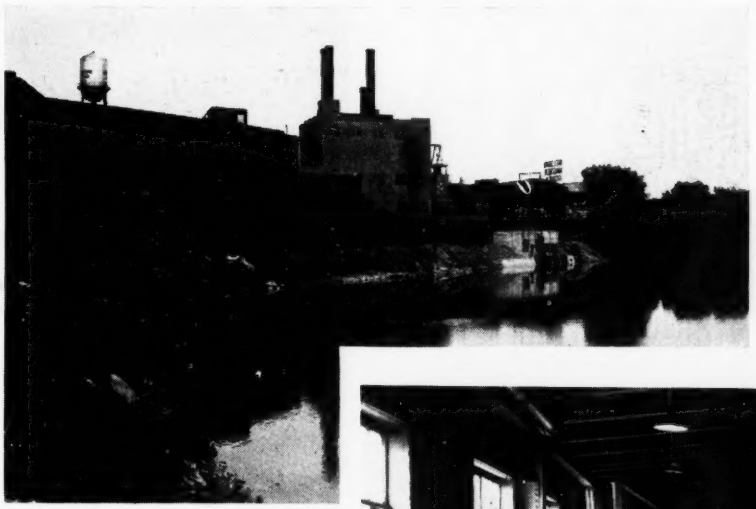


Fig. 6 (Left). General view of the B. F. Nelson Mfg. Co. plant at Minneapolis

Fig. 7 (Below). This photograph shows the coal handling equipment at the top of the boiler house. It shows the distributing conveyor above the overhead coal bunkers

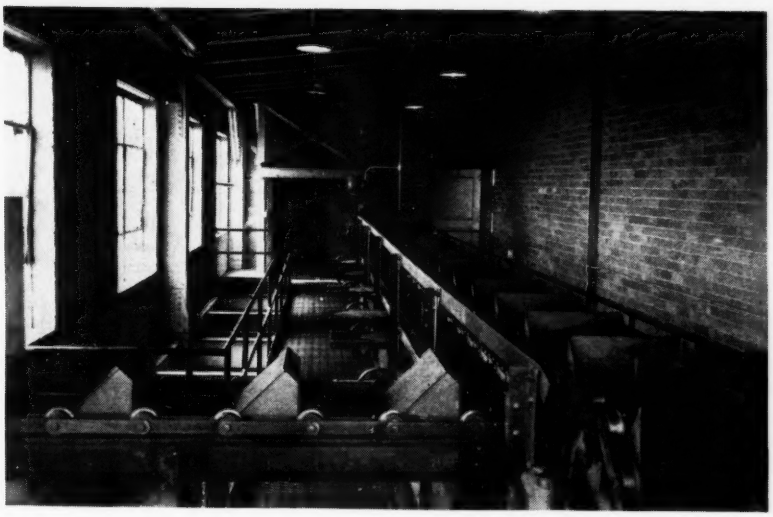


Fig. 8 (Below). Coal delivered by railroad cars is dumped into a track hopper and then this vertical elevator installed on the outside of the boiler house building carries it to the distributing conveyor shown in Fig. 7

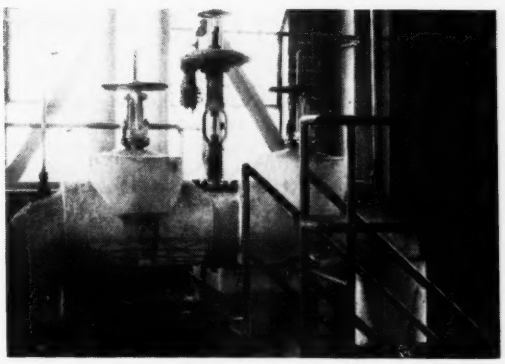


Fig. 9 (Left). This reducing valve reduces the pressure of all steam produced from 400 psi to 160 psi

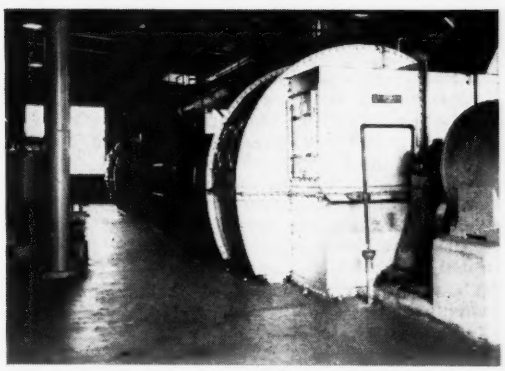


Fig. 10 (Right). A view of the induced draft fan floor

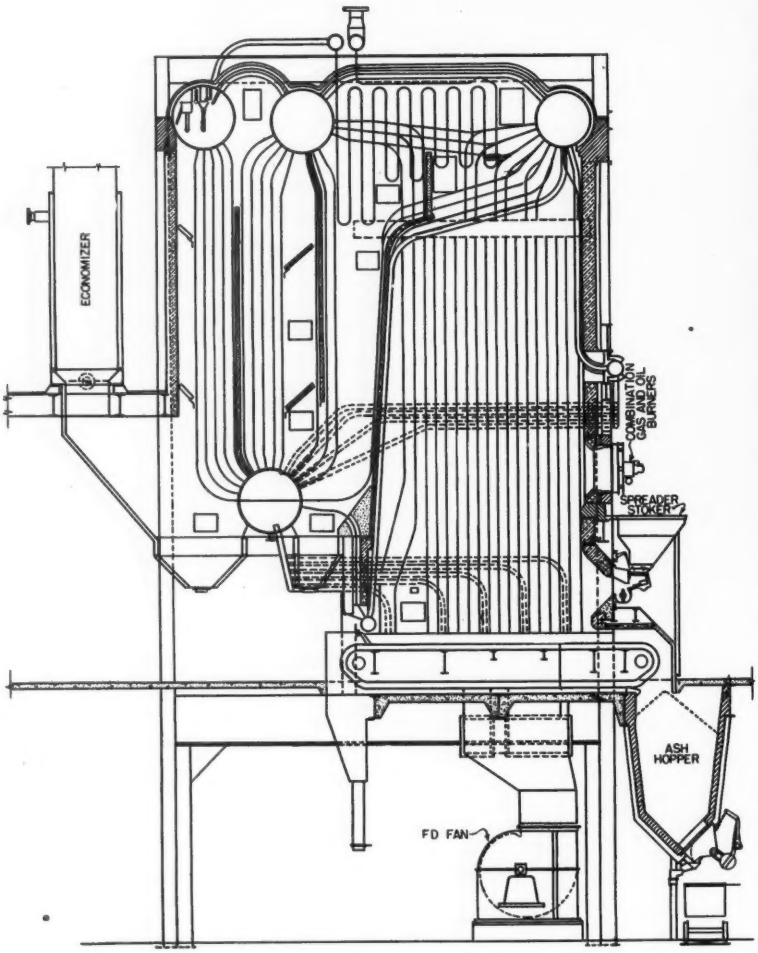


Fig. 11. Cross section of one of the boilers

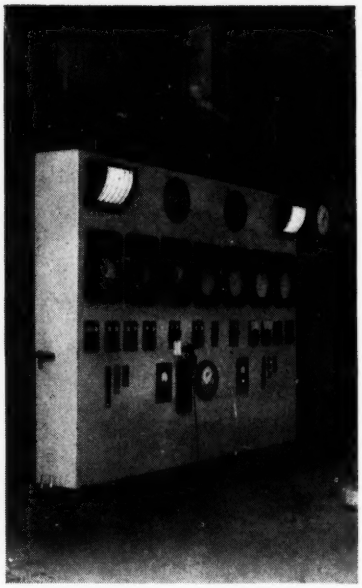


Fig. 12. The main boiler control board on the operating floor in front of the boilers

of the boilers. This board has mounted on it, seven Bailey recording meters, two multi-pointer draft gages, one master Bailey control and eight standard controls, two Copes feedwater regulator controls, two Photoswitch Densometers and other miscellaneous control and indicating equipment.

Each gas burner is equipped with a Wheelco flame failure control so that in case of momentary loss of ignition, that burner is instantly shut off.

All Steam Reduced From 400 to 160 psi

Steam is generated at 400 psi, 650 F and all the main turbine driven auxiliaries operate at that pressure. At present all low pressure (16) psi) steam used in the mill is taken direct from the 400 psi main steam header through desuperheaters and a reducing valve. It was felt that while the turbines were being installed, this method of operation was preferable to the alternative method of operating the high pressure boilers temporarily at 160 lb. This, it was believed, would have caused difficulty with the superheaters as well as with the combustion control system. The modern reducing valve furthermore is a highly effective and efficient device and not the slightest trouble has been encountered in reducing practically the entire steam output of the new boilers.

Each of the two boilers are connected to a 12 in. high pressure common steam header by 8 in. lines. This main header which runs horizontally behind the boilers is provided with a 10 in. connection for the turbines. At one end this header connects into two 10 in. desuperheated steam lines which form a loop and connect to the main 4 in. reducing valve. The control panel for the pressure reducing valve is located on the operating floor directly underneath the valve itself. The 160 psi line to the mill is provided with three 4 in. Crosby safety valves. The first of these three valves—the one nearest the reducing valve—is set to blow at 185 psi, the second one at 190 psi and the third at 195 psi.

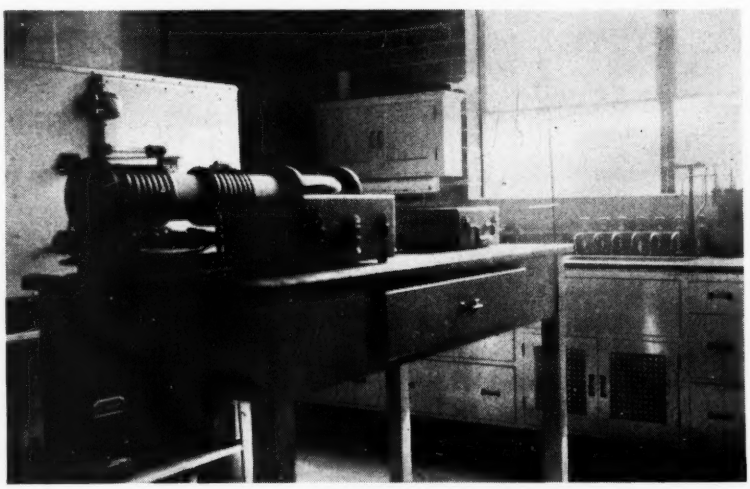


Fig. 13. A view in the chemical laboratory where water is tested

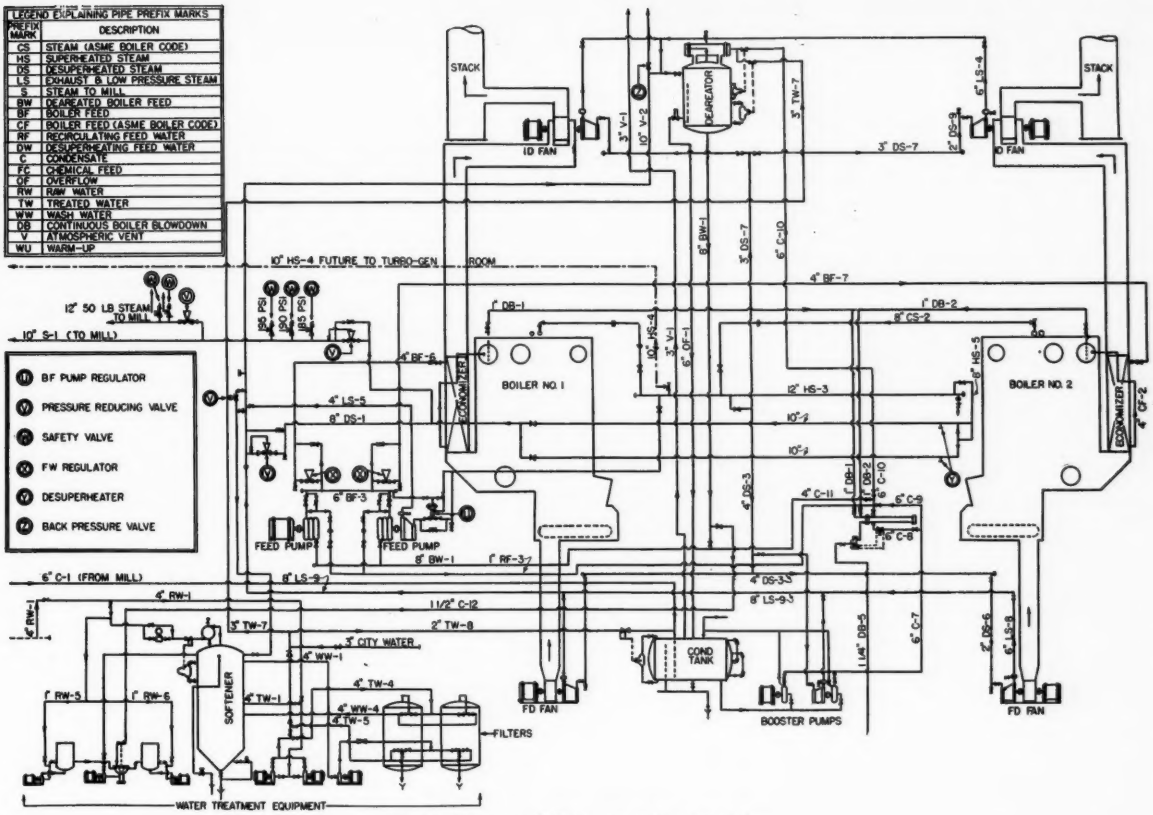


Fig. 14. Diagram of the steam and water piping

A certain amount of 50 lb steam is required in the mill so this is derived from the 160 lb line through another reducing valve operating at 160/50 lb. Finally there is a reducing valve between the 400 psi desuperheated steam line and the 30 lb exhaust line to the deaerating heater, to supply steam for feedwater heating at times when the auxiliaries are on electric operation.

The plant is well designed from an operating standpoint. The entire control is centered in the main control board on the operating floor in front of the boilers. The boiler feed pump and the desuperheating and reducing valve control panel also are on this floor.

The feedwater treating equipment, including the filters, are located on the ground or basement floor level. Here also is located a U. S. Hoffman Machine Corp. vacuum sweeping system to facilitate in keeping the plant clean.

Two Chicago Pneumatic Tool Co. air compressors are installed on the ground floor level. These are 10 by 11 in. units, driven by 50 hp Westinghouse induction motors. These deliver air into two main receivers. A separate small air receiver is provided for the air puff soot blowers.

The plant was designed by Frederick L. Smith, consulting engineer of New York, under whose supervision all construction work was carried out.

BUREAU OF RECLAMATION ORDERS FINAL GENERATORS FOR GRAND COULEE

THE BUREAU OF RECLAMATION has called for bids on the final three giant generators for the Grand Coulee Dam's East Powerhouse, which will place man's greatest concrete dam far ahead of any in the world as the biggest producer of hydroelectric energy.

To be known as Units R-7, 8, and 9, the generators are scheduled for installation in 1951. The bid call covers installation as well as manufacture.

The installed rated capacity of major units at the Grand Coulee Dam today is 912,000 kw. The plant's actual capacity is about 1,150,000 kw. Next year, when the first three East Powerhouse generators are scheduled to be in service, its rated capacity will jump to 1,296,000 kw and its peak performance will be about 1,500,000 kw. In 1950, with six East Powerhouse units operating in addition to the 9 West Powerhouse generators, its rated capacity will increase to 1,620,000 kw and its peak performance is anticipated to be about 1,900,000 kw.

When the three units covered in this last bid call are installed, the power plant will have a total of 18 major units operating in the East and the West Powerhouses and the rated capacity will reach 1,944,000 kw. Its peaking capacity probably will be about 2,300,000 kw, or the tremendous total of about 3,000,000 hp.

Not included in this total are three 10,000-kw station-service units whose output is intended chiefly for use in the Coulee Dam area. Two of these smaller units have been installed and bids have been called for the third.

Sale of power generated by the major units at the dam will pay more than three-fourths the cost of building the self-liquidating Columbia Basin Project irrigation system.

With the value of electrical energy produced at the Grand Coulee Dam approximating $45,000 per day, the total will jump to about $90,000 daily when Units R-7, 8, and 9 are operating.

Because of the strong demand for electricity throughout the Pacific Northwest, the Grand Coulee Dam Power Plant today is producing far greater amounts of commercial energy than during its war-time peak. Its record for a 24-hour period during World War II was 21,801,000 kwh. The plant today frequently surpasses 24,000,000 kwh in a 24-hour period, Bureau records show.

Flow Meter for Coal-Air Mixtures

Uses nozzle and orifice in series . . . Measures coal within ±5% in flowing mixture of pulverized coal and air . . . May be applied in measuring and controlling pulverized-coal-burning equipment . . . Rubber facing on orifice plate a unique feature . . . Action, theory and development of the meter explained

By **H. M. CARLSON,** Research Engineer, Battelle Memorial Institute

METER THAT measures rate of flow of both constituents, in mixtures of air and pulverized coal, has been developed, in the course of research on the fundamentals of flow of air and pulverized coal, by Battelle Memorial Institute, for Bituminous Coal Research, Inc. The meter will measure rate of flow of coal with an accuracy of + 5 per cent, in mixtures of 0.5 to 1.4 lb coal per lb air and for coal pulverized to 75 to 92 per cent through 200 mesh.

The principle of the meter is based on the discovery of discriminate action of the pulverized coal in the airstream; the coal affects only slightly the differential across a sharp-edged orifice; whereas it quite perceptibly affects the differential across a nozzle. This discovery led to placing two elements, an orifice, and a nozzle, in series, as in Fig. 1, to measure the flow of both air and coal at any point in a coal-air line.

Although a completely satisfactory theory for action of the meter has not been developed, the simplest theory to explain the difference in action of air-suspended solids, when passing through an orifice or nozzle, is that the particles do not have time to accelerate in the abrupt contraction of the orifice, where acceleration alone is measured, but do have time to accelerate in the gradual constriction of the nozzle.

Calculating Coal Flow

The rate of flow of coal is computed from the formula which was derived by combining algebraically the flow formulas of the two elements. This formula is:

$$W_c = (W_{an}^2 \div W_a) - W_a$$

in which

W_c = weight rate of coal flow, lb per hr;

W_{an} = indicated air flow rate through the nozzle, lb per hr;

W_a = weight rate of air flow through the orifice, lb per hr.

To compute the weight of coal flowing at a given time, the flow indications of the orifice and nozzle are determined by using standard flow formulas, and the results are then substituted in the above formula. For a complete analysis and derivation of the computations, the reader is referred to the technical paper on the meter, published in the *Transactions* of the ASME, February, 1948, pages 65 to 79.

Performance of Laboratory Meters

Laboratory work with this instrument has given satisfactory results in several installations. The original use of the meter was in connection with the measurement of coal-feed rate in the pulverized-coal and air-circulating system for a radiant-tube furnace. The conveying air was measured by means of an orifice in the inlet pipe to the blower for the circulating system. The coal was fed to the blower inlet from a bin on a scale, by means of a screw feeder, so that, by means of weight and time readings, the feed rate could be determined. After the coal had passed the furnace and meter, it flowed on to a cyclone collector, where the coal and air were separated and the nearly clean air was exhausted to the atmosphere. The successful results of this first work were encouraging.

In order to investigate the performance of a larger meter, a vertical line of standard 4-in. pipe was installed in connection with the same feeding and collecting equipment, but with a larger blower. Greater air capacity was desired, not only because of the larger system, but also to maintain the Reynolds number for the two meter elements high enough so that the coefficients would remain practically constant over the desired range of flow rates. This was necessary because at Reynolds numbers under 100,000 the coefficients may vary enough to require determination of their value at each flow rate.

In most of the tests, the following procedure was used: A clean-air test was first run to check the operation of the orifice, nozzle, manometers, and gages. Then the coal feeder was started, and the coal-air ratio was increased, in steps, to the maximum permitted by the equipment; it was then decreased, in steps, to check the data taken when decreasing the coal feed. The blower was handling the maximum amount of air possible before the coal feeder was started; hence, while the coal-feed rate was increased, the amount of air entering the system gradually decreased because the energy to convey the coal was derived from the moving air, which in turn received its energy from the fan. In a few tests, the air entering the system was kept constant and only the rate of coal food was changed. The performance of the meter under these conditions verified previous results.

Laboratory performance of the meter in ¾- , 1½- , 2- , and 4-in. nominal pipe diameter lines signifies that the meter may offer a means for measuring coal flow in larger, industrial, coal-air lines. Since there was little difference in the operation of the meter when used in these small lines, it seems reasonable to

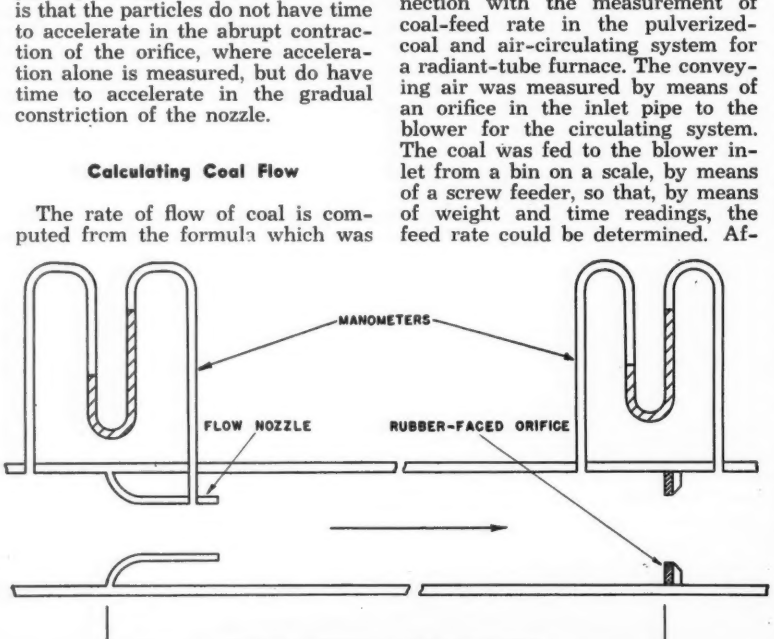
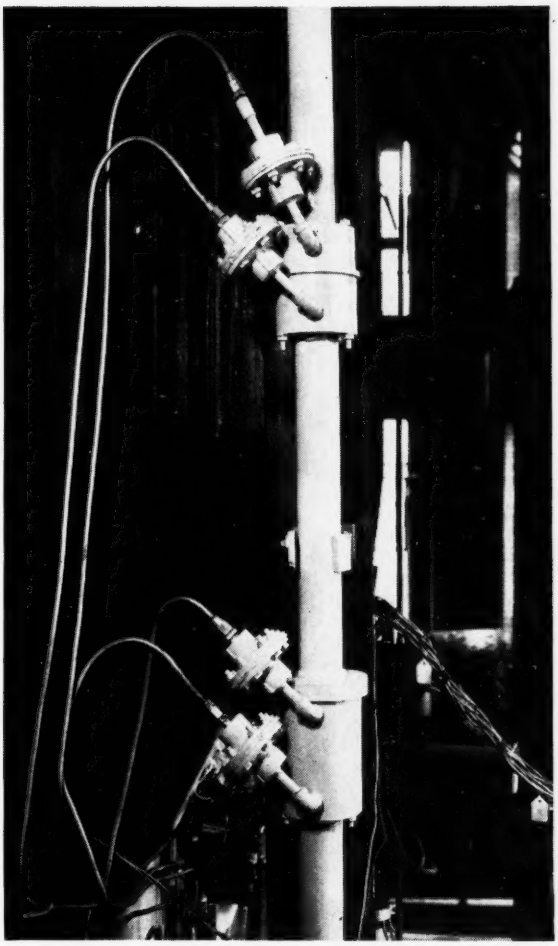


Fig. 1. Diagram showing principle and construction of elements of coal-air flow meter



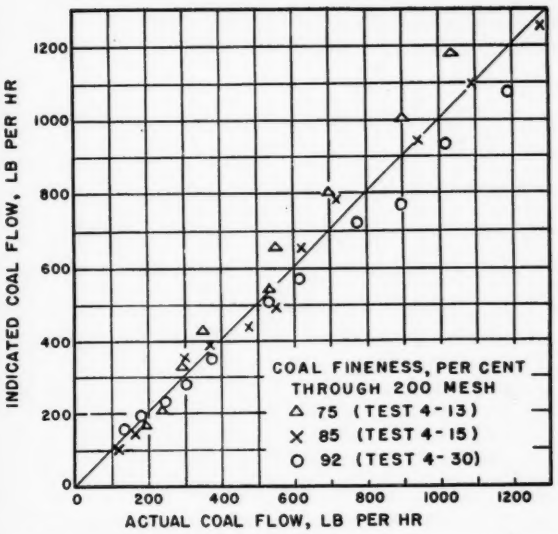


Fig. 3. Graph showing effect of coal fineness on uncorrected coal flow

Fig. 2. View of coal-air meter installed in low-pressure coal-air supply line

expect that operation in larger lines would not be significantly different.

Inasmuch as the assumption was made that the meter operates on the principle of the difference in acceleration of the particles as they pass through the constriction, it appeared likely that particle size would affect the operation of the meter. Three groups of tests were run to investigate this effect, using coals of 75, 85, and 92 per cent through 200-mesh screen. Figure 3 gives the results of three of these tests, indicating that for fineness above 85 per cent, the meter registers less than actual flow, and for fineness below 85 per cent it registers more than actual flow. Correct indication of coal flow is obtained by using a correction factor, which is determined by calibration and then applied to the formula.

A unique feature of the meter is the use of an orifice that has a rubber facing bonded to its upstream side. The brass orifice initially used soon accumulated on its face a hard crust of coal which increased the orifice coefficient. It was believed that this build-up on the face of the orifice was the result of the coal particles impinging on the hard brass surface, sticking and accumulating as the flow of the mixture continued. This problem was solved by the use of the rubber-faced orifice. In making this orifice, conventional lathe tools tended to tear the facing, but a very satisfactory edge was obtained by using a coarse grinding wheel turning at high speed. It is believed that the particles of coal that impinge on the rubber surface rebound, and are carried through the orifice by the oncoming stream, because no further difficulty was experienced with coal settling or accumulating on the face of the orifice.

Applications of The Meter

Following its development, the meter was applied to measure the rate of flow of coal and air in a ¾-in. line in which pressures up to 100 psi were being used. This application was not entirely successful because it was almost impossible to keep manometers and filters free of coal dust. The rapid pressure fluctuations in the coal-air line, and the difficulty of keeping all manometer lines absolutely airtight at this pressure, were major factors that contributed to the unsuccessful operation of the meter, and thereby affirmed the need for perfectly tight connections to all instruments used with this meter.

Figure 2 shows the installation of the flowmeter, in a 1-½-in. coal-air supply line, which served to indicate the coal feed rate to a pulverized coal combustion unit where pressures up to 15 psi were used; the meter also served to indicate instantaneously to the operator any irregularity in coal feed.

Industrial Applications

This instrument has a number of possible industrial applications; one important use is in the control of coal-air flow to pulverized-coal-burning equipment. The line in which the meter is installed should have a straight length long enough to eliminate the effect of bends and turns before the coal-air mixture reaches the meter. Likewise, the system must be able to stand the additional pressure drop which is added to the system by the installation of the meter.

Another possible field of application is in the measurement of finely divided solids flowing in gas streams, such as those found in some of the catalytic-cracking processes. An investigation into the use of this meter for automatic registration and control revealed that instrumentation for instantaneous indication would be possible, but quite complex and therefore costly; whereas its use for control purposes would be very simple. The research field provides other applications for this instrument, where it is necessary to know the amount of finely divided solids flowing in gas streams.

Utilities' Materials Handling Problems

Part II. In the first part of this article, Mr. Clark discussed the practice of the Detroit Edison Company in the handling of power plant materials and equipment and overhead lines materials. Here, he continues with a description of the methods used in the handling of 1, underground lines materials, 2 substation equipment and supplies and, 3, general hauling of materials and equipment. As indicated in the first part in the September issue, this article is based on an address delivered by the author a short time ago before the National Materials Handling Exposition in Cleveland

By R. A. CLARK, Assistant General Storekeeper, The Detroit Edison Company

THE UNDERGROUND electrical distribution system is pretty largely concentrated in the metropolitan area of Detroit. Some cable is used underground in and adjacent to outlying substations and plants, however. The Underground Lines Department construct, maintain and operate the underground cable lines, as well as the steam pipe lines used to distribute central heating steam in central Detroit.

III. Underground Lines Materials

About 2000 items are carried in stock to supply the needs of the Underground Lines Department in its work. For the most part, these consist of about 150 sizes and types of wire and lead covered cable, about 700 items of special electrical fittings used in splicing the cable and making up terminals where the cable joins to overhead or other conductors. About 600 items of pipe, pipe fittings, and valves are carried for steam distribution work, and about 400 items such as sand, gravel, conduit, brick, structural steel, and miscellaneous small hardware items are carried for the construction of the underground steam pipe tunnels and conduit runs and their respective access manholes.

Cable is received from the suppliers usually in 2000-ft lengths on reels as large as 8-ft diameter and weighing up to 12 tons each. Lengths required for jobs, up to about 400 ft, are measured and transferred to smaller reels of about 6-ft diameter for delivery to the job. The majority of cable can be stored in a yard out of doors. However, during cold weather, it is necessary to keep the cable warm so that it can be bent and otherwise handled without damage. To this end it is necessary to keep a number of reels indoors where it can be kept warm, and where power driven machines are located for turning the reels when transferring from one reel to another. An overhead traveling crane is used to handle the reels inside the building. This crane is used to unload the cable from railroad cars or common carrier trucks as it is received from the suppliers. Reels are moved into yard storage with a low slung trailer pulled by a tractor. The reels are rolled onto the trailer from the side, using a rope and a winch driven by the tractor.

When deliveries are made to the job, the reels are loaded onto a low trailer having a capacity of three to four reels, using the same method of loading or unloading by means of winch and rope. The reels are rolled off the trailer onto the street or sidewalk at the curb as specified by the Underground Lines Department. The Underground Crew then mounts the reel on an axle bar between large wheels about 7 ft in diameter, using jacks to lift the reel into position. They can then move the cable on the large wheels into

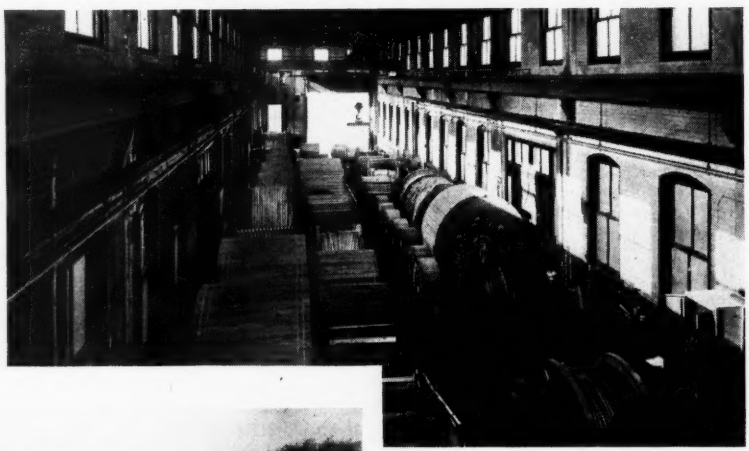


Fig. 1. (Above). Cable storage warehouse. During cold weather a number of cable reels are kept indoors where they can be kept warm

Fig. 2. (Left). Cable storage yard. Cable is received from the suppliers in 2000 ft lengths on reels as large as 8 ft in diameter and weighing up to 12 tons each

position at the manhole, and pay the cable off the reel which is free to turn on the axle bar. Since the work connected with cable installation is usually done in heavily congested traffic areas, ease of maneuverability is important in the type of equipment used.

Other materials, such as manhole construction supplies and cable splicing supplies are stored in a centrally located stockroom and are assembled into quantities required for various jobs in similar manner to that employed in the handling of Overhead Lines supplies, and are loaded onto the Underground Department trucks at the warehouse.

A special handling job is now being developed in connection with the installation of about 13 miles of underground 132,000-v cable line. It is planned that this cable will be

Fig. 4. (Above). Manhole construction supplies

Fig. 3. Cable reel tractor and trailer

received at a warehouse by railroad, on reels about 9 foot in diameter, and weighing upwards of 15 tons each. Due to the fact that a large portion of the cable will be installed this winter, special arrangements are being made to keep the cable warm from the time it leaves the warehouse until it is pulled into place on the job. The cable will be loaded onto trailers—three being required—in a saddle ready to be pulled off the reel. The reels will be covered with a canvas enclosure, and portable heaters will be used to keep the enclosure warm while enroute and while the cable is being pulled into place. The three trailers will be spotted near the manhole and the cable pulled off the reels, after which the trailers will be returned to the warehouse to exchange the empty reels for full ones.

IV. Substation Equipment and Supplies

Substation type of equipment consists of such things as high voltage power transformers and regulators, high voltage oil-filled circuit breakers, manually operated disconnect switches, insulators, switchboard instruments such as volt-meters, ammeters, and relays, and numerous wiring supplies required in substation construction and operation. In all, about 5000 stock items are carried at one warehouse for substation construction, maintenance and operation. Better than 3000 of these are of a "spare part" nature, either spare transformers, regulators, switches, etc, or maintenance parts for the repair of substation tpe of equipment. In this respect, these require the same sort of handling and storing as power plant equipment. Some of this equipment is quite heavy and consequently requires special type of handling. Some transformers for instance run as tall as 20 ft overall, and up to as much as 50 tons in weight. Heavy traveling cranes, up to 60 tons capacity are required to handle them inside the warehouse, where they are unloaded from railroad cars and tested before being put into use.

In transporting such large equipment to the job from the warehouse, a special heavy duty low trailer of 60-ton capacity is used. Special permits are required for moving this type of equipment through the streets, and line crews are required to lift electric lines clear for the passage of such high loads.

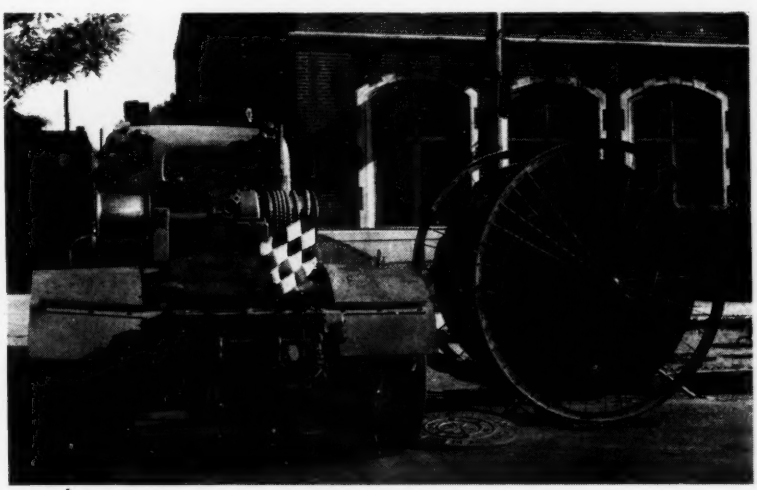


Fig. 5. Cable on reel at manhole

Fig. 6. Cable reel truck

Fig. 7. Underground supplies stockroom

Special containers have been built for the purpose of transporting delicate instruments and breakable insulator bushings used on power equipment. These are used to move this equipment from the warehouse to the job, and to bring equipment from a job into the warehouse or shop for inspection or repair.

V. General Hauling of Materials and Equipment

Some departments of a utility operate trucks in their work and use them for hauling materials they use in their work from the warehouse to the job. As for example, the Overhead Lines Department use trucks to transport both materials and men to the job.

However, a trucking system is required in a large utility to do the general hauling in the distribution of supplies over the whole area. Supplies are hauled from warehouses to construction jobs all over the system—to power plants, substations and sale offices. Considerable transferring of materials between warehouses also is necessary. Materials removed from service all over the system are hauled in to a salvage headquarters for disposal.

Besides the general run of supplies carried in the various warehouses—office supplies, janitors supplies, etc., which are generally used throughout the territory, and electric meters and appliances for sale which are distributed to all Sales offices and the like, the trucking system is called upon to haul construction tools and equipment to jobs, and equipment of all sorts to shops for repair, even called upon to haul the coal burned in the boilers of three central steam heating plants from a riverside unloading dock.

With a fleet of 17 trucks, 19 tractors and 37 trailers and semi-trailers, the division hauls about 75,000 tons of miscellaneous materials and equipment and 225,000 tons of coal annually, over about 480,000 miles. The cost of operation runs about $400,000 annually. The loading and unloading of these trucks presents probably our largest single material handling problem. Our experience has shown that about 50 per cent of the tractor operating time is used while standing idle at a warehouse dock or at a job being loaded or unloaded. We are seeking improvements in this operation which will cut down this lost operating time.

At present, we are experimenting with containers which can be easily moved about, and loaded and unloaded from the truck at all locations. These containers, in combination with additional semi—and four-wheel trailers seem to offer great possibility. The containers must be so designed as to utilize the maximum space on the trucks, yet be of such dimensions as to efficiently contain the large variety of items handled. The containers should be easily portable, by means of either lift trucks or overhead traveling cranes, or on casters for locations where lift trucks or cranes are not available.

Containers with some sort of locking arrangement are needed to prevent pilfering of valuable materials, such as appliances being delivered from the warehouse to the sales rooms.

It is expected that these containers would sometimes need to be used as oneway shippers, so that

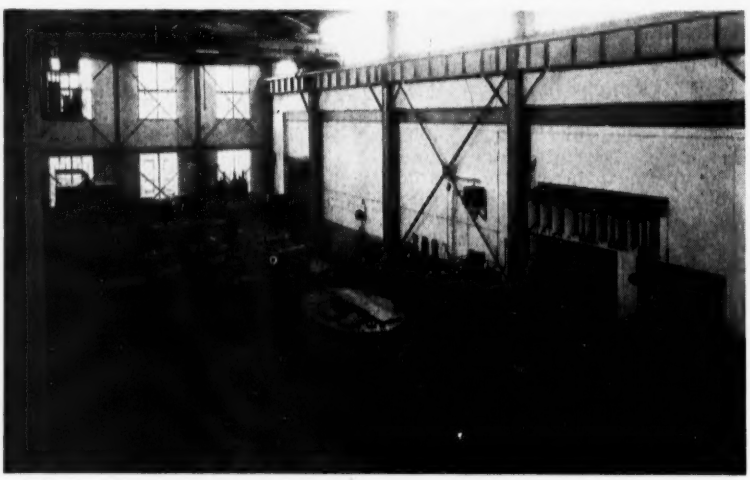


Fig. 8. Substation equipment warehouse craneway

they should be collapsible for return to the warehouse. For some years, now, we have used steel shop pans for the shipment of small materials and they have worked out quite satisfactorily. Both the nesting type and the stacking type of pan have proven useful.

Not all locations have truck-level docks for loading and unloading, so that winches and skids are resorted to in loading some types of equipment. Portable truck cranes are used, not only in loading and unloading trucks where required, but in placing equipment in position at construction jobs. Elevating tailgates can be used to advantage in the handling of certain equipment on and off trucks—heavy electrical appliances such as refrigerators, for example. High lift trucks have been found to be useful in placing materials on trucks in locations where truck level docks are not available.

A yard-type high lift fork truck of 7½-tons capacity is at present being obtained for use in handling cable reels and other types of materials stored in a yard, and it is expected that through the use of a detachable boom, it will be possible to use the truck to handle wood poles, and street lighting poles. We are hoping to be able to unload a whole load of old wood poles from a truck-trailer with the forks, instead at one at a time as at present.

VI. Summary

To summarize, a public utility certainly does have a wide-spread material handling problem. And that is the key of the problem. So many different items are handled, scattered over such a large range of territory in numerous warehouse locations. The quantity and bulk of most of the items carried at each warehouse does not seem to justify large investments in mechanical handling equipment such as lift trucks, at each of these warehouses. Nor does the quantity of these items permit the desirable gains from palletization, unless special racks were used to stack the pallets into, in order to have ready access to all the materials.

And yet, lift trucks and palletization can do a lot of good with certain types of materials. For a number of years we have used skid platforms to a good advantage for the handling and transportation of removal materials from the warehouses into the Salvage headquarters. High lift trucks are used at the Salvage Shop

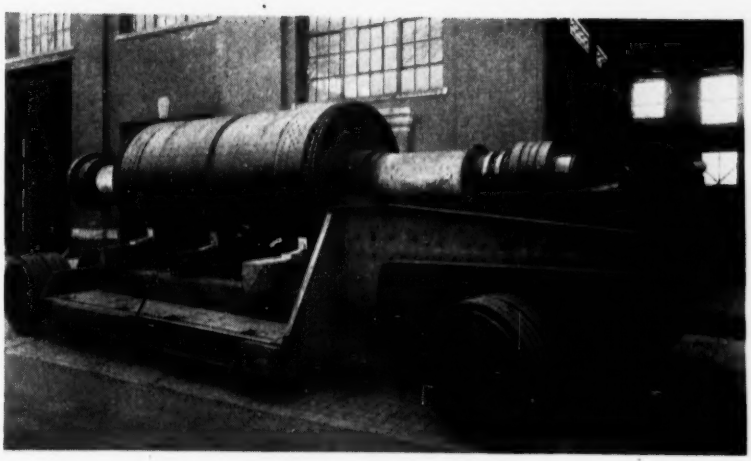


Fig. 9. Heavy equipment hauling

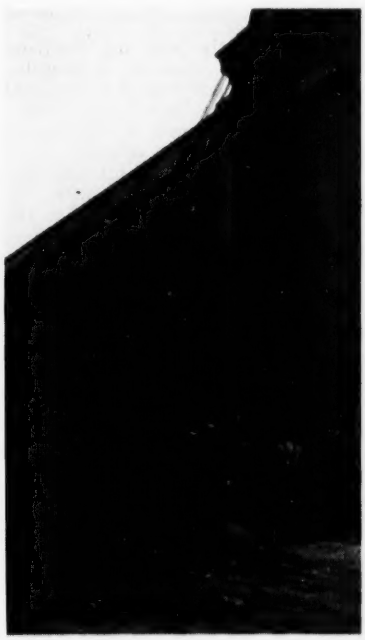


Fig. 10. (Above) Portable crane setting transformer support

Fig. 11. (Right) Portable crane setting transformer

Fig. 12. Small suburban warehouse

Fig. 13. Heavy machine hauling

to handle these skid platforms of materials, and to perform countless other jobs connected with the shop operations performed on these materials—such jobs as loading piles of scrap wire into an incinerator furnace where the insulation is burned off, and removing the tangled mass of copper wire after the burning operation.

We hope to be able to do more with the newer types of equipment coming out,—smaller sized lift trucks, portable conveyors, containers, and the like. We hope to find applications for new equipment which would help in solving our particular problems.

50,000,000-VOLT X-RAYS TO BE GENERATED BY G-E BETATRON

A 50-MILLION volt betatron to produce high-energy X rays that may have value in cancer treatment has been announced by the General Electric Research Laboratory. The new device, weighing about eight tons, is a compact version of the 135-ton hundred million-volt betatron which has been in use here for several years in atomic research.

According to Dr. Ernest E. Charlton, head of the X-Ray Section of the Laboratory, research shows that radiation of 50 million volts will penetrate into the body more deeply and effectively than those of lower voltage.

A machine of this size may be mounted on trunnions so the beam may be directed toward the patient at any desired angle, something hardly feasible with the 135-ton betatron.

No medical experiments have yet been made with the 50,000,000-volt device and none are now planned, declared Dr. Charlton. "This is hardly within our province," he said, "but we hope that properly qualified medical scientists will explore the possibilities of these radiations which are now available." He added, however, that the new betatron will be used in connection with a program to be conducted with the support of the Atomic Energy Commission by the Biology Department of Union College in Schenectady, N. Y., studying the effects of high-energy radiation on living organisms.

This is the fourth betatron built in the G-E Research Laboratory. The first, a 20,000,000 volts, was loaned to the University of Illinois. Second was the 135-ton giant, and then came a 10,000,000-volt machine to produce penetrating X rays for industrial inspection. In addition, a second 50,000,000-volt betatron is being built in the Company's General Engineering and Consulting Laboratory, with Research Laboratory assistance, for the National Bureau of Standards in Washington.

The betatron consists principally of a large electromagnet. In the heart of the device, between circular polefaces, is a doughnut-shaped vacuum tube. Electrons, emitted from a hot filament inside the tube, are whirled around thousands of times and are constantly accelerated while the magnetic field builds up. As the field reaches its maximum the orbit of the whirling electrons is shifted and they hit a tungsten target which they missed on previous trips. This generates a beam of high-voltage X-rays, and occurs at the rate of 60 times per second.

Dr. Charlton credited his associate, Dr. W. F. Westendorp, with the "biasing" technique that makes the new betatron so compact. These machines work on alternating current, in which the voltage starts at zero, builds up to maximum, returns to zero, reaches a maximum in the other direction and returns to zero again. This cycle may be repeated 60 times each second. In the 100,000,000-volt equipment, electrons are injected at the start of the cycle and removed when it reaches its first peak.

Dr. Westendorp's method involves special "bucking" coils which carry alternating and direct current. The effect of the biasing direct current is to shift the zero line of the cycle so that the electrons may be introduced earlier. Then they can be accelerated over approximately a third of the entire cycle instead of only a quarter. With more trips around the doughnut, they acquire greater energy.

The TRANSISTOR — A Crystal Triode

The Transistor is Bell Telephone Laboratories' latest contribution to electronics and electrical communication. Working on an entirely new principle discovered by the Laboratories in the course of fundamental research into the electrical properties of solids, the device will serve as an amplifier or an oscillator—perform nearly all of the functions of an ordinary vacuum tube, but involves no vacuum, no glass envelope, no grid, no plate, no cathode and therefore no warm-up delay. Contained in a simple metal cylinder, scarcely larger than a shoe-lace tip, the transistor produces amplifications as high as 100 to 1 — 20 decibels. Some test models have been operated as amplifiers at frequencies as high as 10 megacycles which at present is the upper limit

AN AMAZINGLY SIMPLE DEVICE, capable of performing efficiently nearly all of the functions of an ordinary vacuum tube, was announced early in July by scientists of the Bell Telephone Laboratories where it was developed. Known as the Transistor, the device works on an entirely new physical principle discovered by the Laboratories in the course of fundamental research into the electrical properties of solids. It is expected to have far reaching significance in electronics and electrical communication.

The transistor is essentially a triode form of the well-known germanium crystal diode. It is still in the experimental stage but in its present form it consists of a tiny metal cylinder only 3/16 in. in diameter and 5/8 in. long. As shown by the cut-away diagram in Fig. 2, inside is a block of semi-conducting metal (germanium)[1] soldered to a metal disc to which it makes a low resistance contact and grounds it to the cylinder. Two 2-mil tungsten wires make "cat whiskers" contact with the upper face of the germanium at points 0.002 in. apart. The device is so small, 7 or 8 of them can be put in an ordinary thimble.

Like a vacuum tube, the transistor can be used as an amplifier or as an oscillator, yet it requires no vacuum and requires no heating current. As shown in the circuit at the left of Fig. 3, when an input signal in series with a small *positive* bias voltage is applied between the grounded face and the input "cat whisker" (called the emitter) an amplified signal appears in the output circuit. The output point of contact is known as the collector and this, as shown, is biased negatively. A power gain of 100 (20 decibels) is obtained in this manner.

The amplification process in the transistor is caused by the fact that the input contact (emitter) is surrounded by an "area of interaction." Within this area the electronic structure of the semiconductor is modified by the input current. If the output contact (collector) is placed in this area, the output current can be controlled by the input current thus producing the basic mechanism of amplification.

Since the circuit amplifies, it can also be made to oscillate by feeding back a portion of the output current to the input circuit. A typical oscillator circuit is shown at the right in Fig. 3. Here, two resonant circuits, one in each branch of the circuit are inductively coupled as shown. In this case, the circuit will oscillate at a frequency which is a function of the constants of the resonant circuits.

Will Have Many Uses

Naturally, these devices because of their inherent simplicity of construction can be expected to have many uses. In one of the demonstrations at the Bell Laboratories, a transistor circuit was used as a telephone repeater. In another case a tubeless radio receiver using a point contact as a detector was operated satisfactorily. A transistor circuit was also used to generate a standard frequency tone, thus demonstrating its capability as an oscillator. Some test models have been operated as amplifiers at frequencies up to ten megacycles but this, with germa-

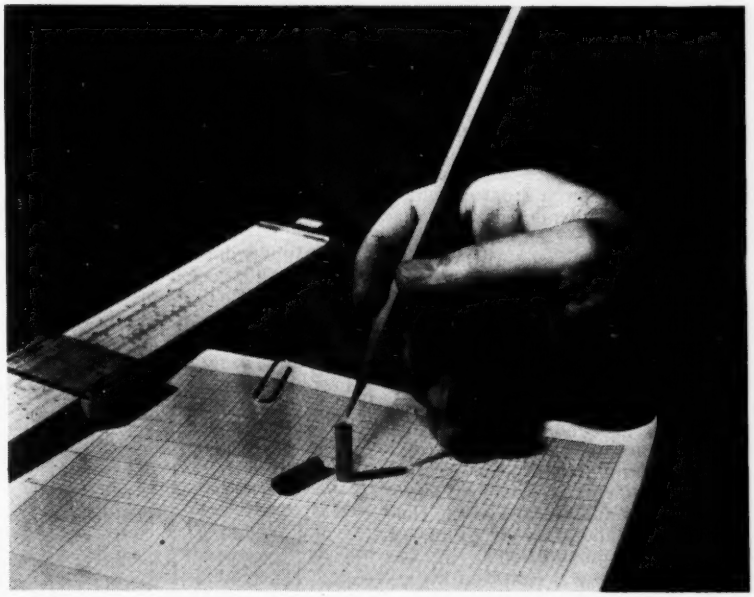


Fig. 1. The transistor

[1] Germanium is grayish-white metal of molecular weight 72.6 and atomic number 32. It is a very rare metal but in late years it has been used extensively in the construction of small rectifiers used in radio receivers and communication equipment generally. In this application it is used as a diode, passing current in one direction but not in the other.

nium, seems to be about the upper limit.

Because of the absence of heater power and its small size—smaller than a subminiature tube—the transistor is destined to have far reaching effect in the field of electronics; undoubtedly, it will replace conventional electron tubes in a wide range of applications. Where low battery drain and portability are essential, as in hearing aids, portable radios, aerial instruments, etc., the transistor seems ideal. It will also find application in systems using large

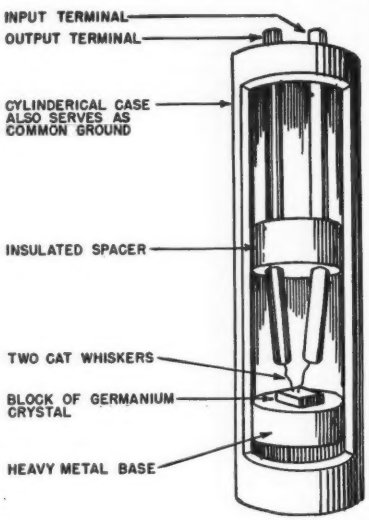


Fig. 2. Cut-away view of the transistor showing the two cat-whiskers in contact with a small block of germanium

numbers of amplifiers such as electric computing machines. With conventional electron tubes in such applications the heat dissipation is always a problem; with transistors the heat problem would be eliminated.

While many scientists have been associated in the development of the transistor, the key investigations were carried out by Dr. John Bardeen and Dr. Walter H. Brattain. The general research program which led to the development of the transistor was initiated and directed by Dr. William Shockley. All are with Bell Telephone Laboratories.

Although the transistor is the direct result of work done in recent years, actual research on semiconductors began almost 25 years ago. The old crystal detectors used in early radio work were devices using semiconductors and as already mention, germanium was used as a rectifier for a number of years. After the war, interest in semiconductors became more intense and at the Bell Telephone Laboratory a group of men under the direction of Dr. Shockley began a program of investigation that finally culminated in these new devices.

[2] See, "A Millionth of a Degree" December 1946, page 95.

Nature of Semiconductors

It was known that the resistivities of the semiconductors was determined largely by impurities and also by external influences. In photocells, light was an important influence; in rectifiers, electric potential exerted a marked effect and in the case of the thermistor[2] the varying influence is temperature. Among the things the scientists were particularly interested in were, 1 the physical nature of a semiconductor, and 2, how does its physical nature produce its observed properties. Besides germanium, other semiconductors investigated were silicon and copper oxide.

To understand the mechanism of semiconductors it is necessary to know something about the nature of electric conduction in ordinary solids. Metals, are composed of atoms in which certain electrons are so loosely associated with atomic groupings that they can easily be induced to move to adjacent atoms. These are the so-called "free" electrons. In metals there is approximately one free electron for every atom and these free electrons can be used for current carrying purposes. In insulators there are practically no free electrons.

In semiconductors there are relatively few free electrons compared to the total number of atoms, probably only one free or current carrying electron for every million atoms. This number of carriers, however, can be varied a thousand fold by changing the physical environment of the material. Such a change in the number of carriers manifests itself as a change in the resistance of the material. In the thermistor, for example, a variation in temperature causes a change in the number of carriers, hence these devices can be used to measure changes in temperature by virtue of the variation in resistance to the flow of current through them.

Movements of electrons account for one of two theories of electric conduction in semiconductors. Semiconductors employing this method are called N-type semiconductors because conduction is by negative (electron) charges. In other types of semiconductors, in which there is a deficiency of electrons, the current consists of the movement of virtual positive charges (images of electrons). These virtual positive changes are actually empty spaces from which electrons have been removed. These semiconductors are called P-type because conduction appears to be by positive charges.

The diagram in Fig. 4 illustrates these two types of conduction. At the left, at A, is shown the structure of pure carbon. It is difficult to produce flow of electricity in a pure semiconductor because the four valence electrons of the carbon atom hold on to corresponding electrons in adjacent atoms tenaciously. The addition of a slight impurity to such an element, however, will change it into a semiconductor of either the N or P type depending upon the nature of the impurity.

In the center of Fig. 4, at B, is shown the structure of N-type silicon. Silicon like carbon has a valence of four and in its pure state is not a conductor of electricity. Suppose, however, as illustrated in Fig. 4, an impurity having an excess of one electron such as phosphorus is added to the pure silicon. Four of the five valence electrons of the phosphorus form bonds with the four valence electrons of the silicon but the fifth one, finding no union with others is free to move under the influence of an electric potential.

If the added impurity lacks the required number of electrons for making bonds the condition shown at C in Fig. 4 arises. Here boron is the added impurity. Boron has only three valence electrons so there is one incomplete bond between each boron atom and a silicon atom leaving a sort of hole in the electronic structure. Since the percentage of impurity is very low only few of the silicon atoms have this bond deficiency, hence the hole in the bond of one silicon atom with a boron atom can be filled with an electron from an adjacent silicon atom under the influence of an electric field. When an electron from a neutral silicon atom departs to fill such a hole in the bond between a silicon and a boron atom, it, naturally, leaves a hole in the atom from which the electron came. The hole, therefore, is free to move from atom to atom but whereas the elec-

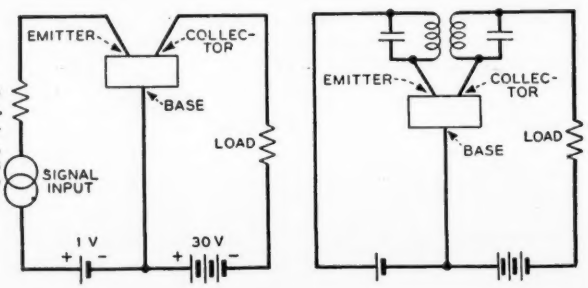


Fig. 3 Two circuits using the transistor. At the left is a typical amplifier circuit, and at the right is a typical oscillator circuit

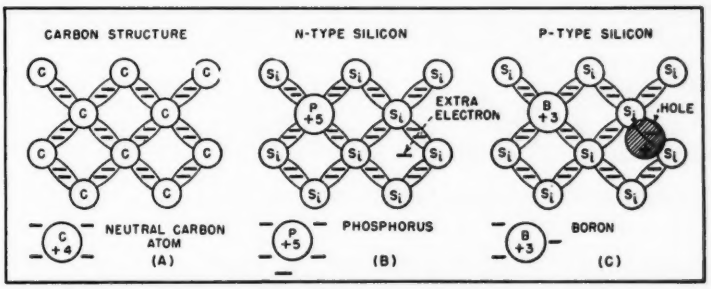


Fig. 4. These diagrams attempt to show the atomic structure of three types of semiconductors. At the left is the structure of pure carbon. It has no impurities. Each atom is held to adjacent atoms by four electronic bonds. In the center, at B, is the structure of N-type silicon. This silicon contains a very small percentage of phosphorus. With five valence electrons, phosphorus forms bonds with four of the silicon electrons but has one left over. This electron, therefore, is free to act as a carrier. At the right, at C, is the structure of P-type silicon. This silicon contains a small amount of boron as shown which has a valence of three. Hence where one of these boron atoms forms a bond with the silicon atoms there is an eletronic "hole" which manifests itself as a positive charge

trons migrate from a negative region to a positive region, the holes move towards the negative region. In substances of this type, the electrons would have no place to go if it were not for the existence of these holes so while electrons do move under the influence of the electric field, it is the presence of the holes that makes their motion possible. Thus, in P-type semiconductors conduction is by positive holes.

These theories of conduction led to experiments which in the end brought forth the transistor. To account for the action of the transistor, Doctors Brattain and Bardeen postulated and later demonstrated the existence of a thin layer of electrons at the surface of the germanium. The electric field created by these surface electrons caused the formation of holes in the adjacent material and these holes as has been explained conduct current. The interior of the metal is an N-type conductor. Between the P-type layer close to the surface and the interior N-type conductor is a rectifying barrier.

When a single point contact is made, the surface layer determines the conductivity for reverse currents or for small forward currents. For large forward currents there is an increase in the concentration of carriers (electrons and holes). In either case, that is with forward or reverse current, a large part of the current is carried by the surface conducting layer within an area of interaction very close to the point. Within this area the conductivity, which is mainly by holes, is much greater than elsewhere in the semiconductor.

If the point of contact in a transistor is given a positive potential by connecting it to the positive terminal of a battery or other source, it will cause the release of holes in the surface layer of the germanium. These holes spread away from the point, flowing in all directions along the surface but not into the body of the material. The holes reach the other contact point 0.002 in. away in less than a ten millionth of a second. This is the transit time that limits the present performance of the transistor to frequencies below ten megacycles. Knowing this it is easy to calculate the rate at which the holes travel; it comes out on the order of 100,000 cm per second. This of course is slow compared to the speeds which electrons travel in a vacuum tube. It may be possible to reduce the transit time by applying higher voltages and using smaller spacings as in the practice in vacuum tubes. From estimates of their thermal velocities it is known that the holes are capable of traveling at from 10 to 100 times this speed.

Now let us see what happens at the collector. This, is biased negatively, hence it causes a small current to flow from the germanium in the absence of hole conduction produced by the emitter. When the positive bias is applied to the emitter, however, the holes which it causes are attracted to the negatively biased collector thus increasing the current in the output circuit. Variations in the input current change the number of holes released toward the collector and thus vary the output current proportionally.

In its performance the transistor resembles a grounded triode circuit. In such a circuit the current from the cathode is controlled largely by the potential between it and the grid, that is, the ground. The plate voltage has little effect. In the transistor the positive bias—about 1 volt—of the emitter causes a small current to flow into the semiconductor. The negative bias, up to 50 volts, of the collector is made large enough so that it withdraws about the same current (a few milliamperes) from the semiconductor. The collector is a poor emitter of electrons but a good collector of holes, hence when the emitter produces an increase in the number of holes the current (carried by the holes) to the collector is varied by a factor of from one to two times the change in the emitter current. Since the emitter current flows through the high impedance of the output circuit, an impedance of the order of 10,000 to 100,000 ohms, the voltage change in the emitter circuit is proportionally large. This results in a corresponding power amplification of the signal.

This, briefly, explains the action of this new device. It is not quite as simple as the action in a vacuum triode but knowing something about the theories of conduction in the semiconductors, the operating characteristics can be explained. In its present form it is a low power device and the power output is restricted to about 25 milliwatts per unit; 50 milliwatts from a push-pul stage. It is possible however, to operate several units in parallel and in this way higher outputs could be secured. In one respect, the transistor has an advantage over the vacuum triode; there can be little coupling from output to input circuit through the transistor itself. The output circuit can influence the input circuit only by electronic conduction, for which the surface resistance is high so there can be little coupling and the circuits, one of low impedance (low power) and the other of high impedance (high power) are properly isolated for use in unilateral amplification. Another advantage is the fact that since no heating current is necessary the transistor is operative the instant power is applied.

There can be no question but that the transistor will profoundly influence the future development of the electronic industry. While it will not replace vacuum tubes generally, it will replace them in many applications where low power levels are used. In an experimental radio receiver at Bell Lab. containing 11 transistors, the receiver brought in local stations, delivering 25 milliwatts of audio power to the loud speaker.—AWK.

TAPPING THIN SHEET METAL

By W. E. WARNER

SOMETIMES HOLES have to be drilled and tapped in thin sheet metal, so thin that only one or two threads can be obtained. In these cases the hole should be drilled 25 per cent undersize. Then get a piece of round tapered steel stock, the small end of which is an easy fit in the hole tapering up to a large end which will be the diameter of the finished hole. This round steel stock should be placed in a ratchet drill and the hole enlarged with it.

While opening out it should be kept well lubricated with a mixture of oil and graphite. Opening out in this way will bell out the walls of the hole on the underside and enable more threads to be obtained.

ATOMICS

A New Section added to POWER GENERATION to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

The Importance of Breeding in Nuclear Power Development

The future development of nuclear energy power plants will depend largely upon a continuous supply of fissile materials. Uranium, though not rare, is sparcely distributed. To augment existing supplies of fissile materials the possibility of "breeding" has become important. This article discusses both the physical as well as the economic aspects of breeding.

By **ANDREW W. KRAMER**, Editor, Power Generation

WHEN the first nuclear reactor went into operation at the University of Chicago on December 2, 1942, two types of chain reactions were started. One, of course, was the self sustaining nuclear chain reaction which has now become so well known, the other was the mental chain reaction which began in the minds of all those directly associated with the work of the Manhattan District and which later on spread to the minds of scientists all over the world. This mental chain reaction is scarcely less important than the nuclear chain reaction itself since it is bound in the long run to lead to developments that may be of much greater significance to the human race than were the first atomic bomb explosions.

Once it was known definitely that a nuclear reaction could be made self sustaining a train of thought was started in every scientific mind throughout the world—a train of thought that is still continuing to develop and bear new fruit every day. Because of the secrecy imposed by military considerations only few people in the world actually know how far we have progressed in our knowledge and technique of nuclear energy but it is safe to assume that our knowledge is accumulating much more rapidly than the comparative lull in atomic energy news might indicate.

In this country all nuclear research is being carried out under the direction of the Atomic Energy Commission. While the Commission cannot disclose anything about the nature of military developments, it is quite obvious from the expenditures that are being made that a great deal of development is going on. Only the meagerest information was issued last spring when new "atomic weapon" tests were conducted at Eniwetok, but the very fact that it was necessary to make these tests indicates that work on atomic bombs is far from being at a standstill. In a conspicuous but masterfully uncommunicative press interview at Fort Shafter, Lt. General John E. Hull, Commander of the Eniwetok task force indicated that the "operation" had been successful. Three "nuclear explosions" it was said had been carried out. What their nature was, whether they were of the plutonium or uranium type or whether they involved the use of hydrogen or lithium, will probably not be known to the ordinary citizen until the all but hysterical efforts to maintain secrecy give way to a degree of common sense. Since the hydrogen-helium and hydrogen-lithium reactions both seem feasible, we can assume that under the veil of secrecy a great deal of research is being conducted in this direction.

Heavy Element Nuclear Reactions

Fortunately the problem of atomic power development, at present at least, is not concerned with any of the light-element nuclear reactions.[1] Power production seems possible now only by means of the controlled process of nuclear fission in isotopes of two of the heaviest elements, i.e. uranium 235, plutonium 239 and uranium 233. Of these three "fissile" materials, only one occurs naturally; this is the natural isotope of uranium, U-235. As is well-known, now, plutonium 239 is a man-made isotope —the result of the capture of a neutron by a U-238 nucleus, U-238, of course, is the abundant isotope of uranium.[2]

Plutonium is automatically produced in any nuclear reactor using

[1] See Eee Equals Em See Squared. By Andrew W. Kramer, Feb. 1947, p. 80. Also Recent Developments in High Energy Physics, By Andrew W. Kramer, Jan. 1948, p. 91.

[2] Natural uranium consists of a mixture of three isotopes in the following proportions: U-238, 99.3 per cent; U-235, 0.7 per cent; and U-234, 0.006 per cent.

natural uranium. As explained in previous articles in these pages[3], the process takes place in three stages:

$$U238 + n \rightarrow U239 \rightarrow Np239 \rightarrow Pu239$$

Beta, 23 Min Beta, 2.3 days

This means that when a neutron, n, is captured by a U 238 nucleus, the latter becomes U-239. This nucleus, however, is unstable—it has a half life of only 23 min. By emitting a beta particle, that is, a negative electron, it changes into a new element neptunium, Np-239 which has a half life of 2.3 days. This, again emits a beta particle thereby becoming plutonium, Pu-239. Note, that in all these transformations, after the capture of the first neutron, the atomic weight undergoes no material change—it remains 239. The emission of the beta particles actually means the conversion of a neutron into a proton. The "bookkeeping" is as follows:

U-238		U-239		Np-239
146 Neutrons	+ 1 Neutron =	147 Neutrons	— 1 electron =	146 Neutrons
92 Protons		92 Protons		93 Protons
238		239		239

Np-239		Pu-239
146 Neutrons	— 1 electron =	145 Neutrons
93 Protons		94 Protons
239		239

This conversion of U-238 into Pu-239 has been described in detail because it is representative of many different nuclear transformations. In a similar way the third fissile material, U-233 is produced from thorium. By neutron capture, thorium, atomic weight 232, (Th-232) is converted by neutron capture into Th-233 which after two radioactive transformations becomes U-233. The reaction is as follows:

$$Th232 + n \rightarrow Th233 \rightarrow Pa233 \rightarrow U233$$

Beta, 23 Min Beta, 27.4 days

Thorium 233 changes into protoactinium (Pa-233) and this in turn, by another radioactive transformation, becomes uranium 233.

Thus far, in the operation of nuclear reactors, only the uranium isotopes U-235 and U-238 have been involved, because these are the two principal constituents of natural uranium. The U-235 is fissible—it undergoes fission as a consequence of the capture of a *slow* neutron. The fission process, however, produces high speed neutrons which are captured by the U-238 nuclei, causing them to be converted into plutonium by the process indicated above. Thus, as the reaction proceeds, U-235 is used up but plutonium appears to replace some of it. If conditions are favorable the reaction will proceed towards a condition in which there is no U-235 left. Plutonium is also a fissile material, however, and from there on all the fission will take place in plutonium.

The fission of each plutonium nucleus, produces additional neutrons which are capable of causing fission in other plutonium atoms as well as of transmuting U-238 nuclei into plutonium. Suppose that for one nucleus of plutonium destroyed by fission some number x, say, of new plutonium nuclei are produced by capture of neutrons in the U-238 nuclei left behind when all the U-235 nuclei were used up.

After a time these x nuclei are

[3] The Development of Atomic Energy, Parts I to V, By Andrew W. Kramer, Oct., Nov., Dec. 1945 and Jan., Feb. 1946.

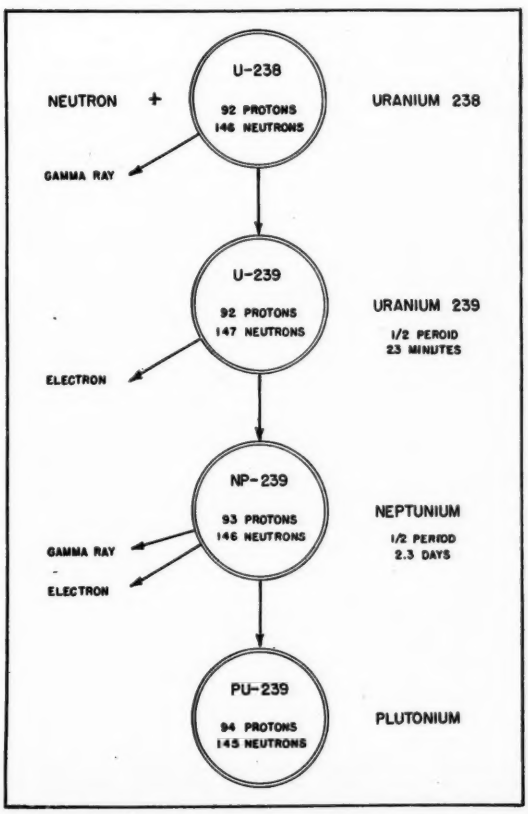


Fig. 1. Capture of a neutron by a nucleus of uranium 238 leads to the synthesis of plutonium

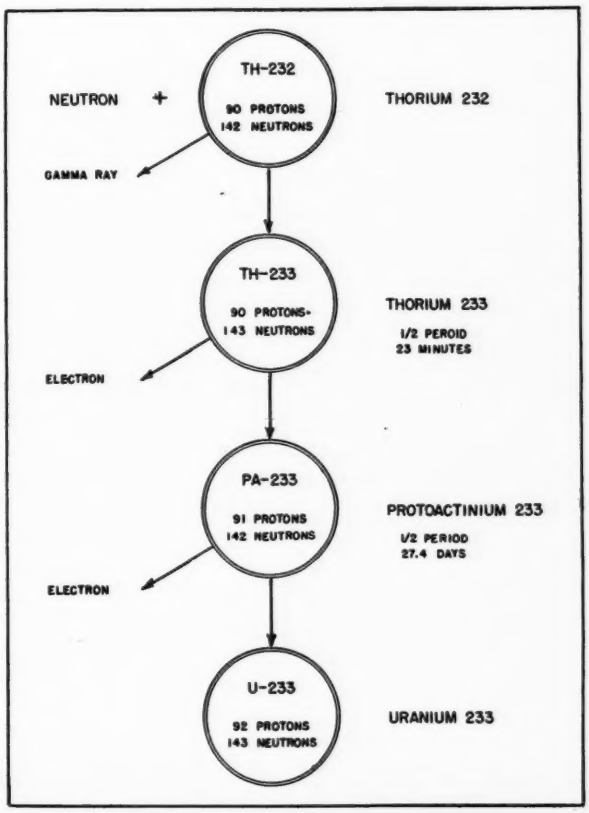


Fig. 2. Steps in the synthesis of uranium 233 from thorium 232

split by fission thereby producing heat (which in the nuclear power plant is the object of the operation) and each one produces x new plutonium nuclei, x^2 in all. These, in their turn produce x^3 plutonium nuclei, and these in turn, x^4 and so on.

Now the extent to which this process continues depends upon the value of x. If x is less than one, the amount of plutonium diminishes, and the total energy generated from plutonium corresponds to the amount of plutonium originally present, multiplied by

$$1+x+x^2+x^3+x^4+\ldots = \frac{1}{1-x}$$

If x is close to 1 this can be quite large. Suppose it is ½. Then

$$\frac{1}{x-½} = \frac{1}{½} = 2$$

In other words, if for each two fissions of plutonium 1 new nucleus of plutonium results, the total amount of energy that can be obtained will be twice that derived directly from the U-235 originally present.

Suppose, however, that instead of x being ½ it is much closer to 1; say it is 9/10. Then

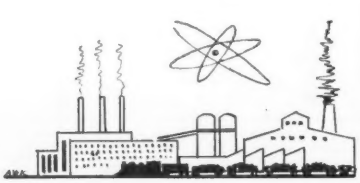
$$\frac{1}{1-9/10} = \frac{1}{1/10} = 10$$

Thus in this case the energy produced will be ten times that of the U-235 initially present. No matter how close x becomes to 1, however, the reaction would eventually cease, despite the presence of ample U-238.

If x becomes 1, then, of course, it is obvious that the process of fission would continue as long as any U-238 remained.

Breeding

Now, let us assume that x is greater than 1, that is, suppose that for every nucleus destroyed by fission, more than 1 nucleus of plutonium is produced. Then, we have a most interesting situation for as the reaction continues the amount of plutonium increases at a rate dependent upon how much greater x is than 1. Under such conditions, the reactor would produce heat in exactly the same manner as before but as the nuclear fuel burned, the reactor would actually produce an excess of plutonium which could be extracted. The increase of plutonium would continue until all the U-238 was used up. If U-238 was introduced continually, the production of plutonium would continue. A breeding system, therefore, may be regarded as one which effectively burns the abundant isotope of uranium. In other words, with a system of this kind, the amount of fissile material in natural uranium instead of being 0.7 per cent (the percentage of U-235 in natural uranium) would be practically 100 per cent.



From this standpoint alone, the breeding process would be well worth while, it would greatly extend the existing uranium reserves, but the process has an even more important bearing on the nuclear fuel situation, with respect to thorium.

As has been explained U-233 can be produced from thorium 232 as a result of neutron capture just as Pu-239 is produced from U-238 as a result of neutron capture. So, U-233 might be bred from thorium. In this case, it would be the thorium which would be burnt up in the course of the reaction. At the beginning, thorium would have to be introduced deliberately into the initial stages which depend upon the fission of U-235 but once started the process would continue in the manner described.

Curiously enough, despite the great amount of research that has been done on nuclear energy phenomena, it is still not known whether breeding is feasible, that is, whether x is greater than 1. Theoretically, breeding is possible, but in practice it has been found extremely difficult to build an industrial reactor that will cause the excess neutrons to be absorbed in a blanket of either U-238 or thorium. The process depends upon a very much more delicate balance of neutron production and utilization than is required for the sustaining of a nuclear chain reaction, and more accurate knowledge of nuclear constants is needed before the problem can be solved. The engineering difficulties associated with breeding are enormous. The conditions which have to be fulfilled to obtain high neutron economy are difficult to reconcile with those needed to obtain a high power output for a given material investment. There are acute chemical engineering problems associated with the repeated treatment of partly depleted fuel and the extraction of new fissile material from the uranium or thorium. All the procedures are, of course, complicated by the enormous radioactivity and have to be repeated many times before the fuel is completely consumed. The process must give virtually complete recovery at each stage if the physical reproduction is to be reflected in active material stocks.

Breeding, nevertheless, is being given a great deal of attention in the various laboratories of the Atomic Energy Commission, since the future of nuclear power may depend to a large extent upon whether or not breeding can be made a reality. Despite the great difficulties involved, there is good reason to believe that a successful solution to the problem will be found.

Breeding or Not-Breeding

In thinking of nuclear energy for power, we must think of it in terms of worldwide use. If nuclear energy is to be used as a source of power, at first, it will be used, probably, in regions where conventional fuels are scarce, but as the technique of using it develops it should gradually replace all our conventional sources of power, for large installations at least.

In a recent article in "Discovery," Dr. M. H. Pryce, Professor of Physics at the University of Oxford and Executive Vice President of the British Atomic Scientists Association, makes some interesting calculations concerning world aspects of

nuclear energy. According to Dr. Pryce, the annual world thermal requirements for all purposes are roughly 3000 Q, Q being an abbreviation for 1000 million kilowatt hours. A substantial part of this heat is used in making electricity. The conversion of heat into electricity, of course, takes place at a low efficiency—around 20 per cent. Hence for each 100Q of heat only 20Q of electricity is developed.

Now one ton of fissile material, if completely used up by fission, releases roughly 20Q of heat. This is equally true for U-233, U-235 and Pu-239. Remember, one Q is equal to 1000 million kwh! It is interesting to compare the 20Q released by one ton of fissile material with coal. *One million tons of coal* furnish roughly 7.5Q. Thus, weight for weight, fissile material yields some *three million times* as much heat as coal.

So, as pointed out by Dr. Pryce, to satisfy the world's annual thermal requirements of 3000Q we need $3000 \div 20$ or 150 tons of fissile material per year.

In terms of raw materials (uranium, thorium) this demand takes very different forms according to whether breeding is or is not, possible. If we consider the pessimistic hypothesis that breeding is possible, then the fissile material available is U-235 together with plutonium formed as a by-product of its fission. The secondary plutonium might

multiply the effective amount of fissile material by a factor of five without straining the hypothesis too much. The raw material in this case is uranium containing 0.7 per cent U-235, equivalent, with this estimate of the effect of secondary plutonium, to $5 \times 0.7 = 3.5$ per cent fissile material for the purpose of heat production. The uranium requirements are, therefore, $150 \times 100 \div 3.5 =$ (roughly) 4000 tons a year.

This 4000 tons a year, assumes that breeding is not possible. Suppose now, we turn to a more optimistic viewpoint—that breeding is possible; then all of the raw material, whatever it may be, uranium or thorium, is converted into fissile material. This means an annual consumption of only 150 tons of uranium or thorium, against 4000 for the case of non-breeding.

These figures provide eloquent testimony to the importance of breeding upon the world's stock of uranium and thorium. As has been explained in the articles appearing in these pages in previous issues, uranium is really not a rare metal. Actually it is more plentiful than gold, but it occurs for the most part in very low concentrations, in rocks such as granite from which it is not economical, at least with present methods, to extract it. There are a few places, such as the Great Bear Lake region in Canada and the Belgian Congo where rich ores are found but these deposits are limited in extent and it is not expected that they can supply our needs for a long time in the future.

Thorium, however, is much more abundant than uranium and even before the war some 500 to 1000 tons a year were mined for industrial purposes. With thorium, assuming the breeding of U-233 the annual demand of 150 tons is quite small compared with the pre-war annual output of thorium and the exhaustion of supplies would be remote. If breeding of U-233 proves feasible, therefore, there is every reason to believe that nuclear energy will play a very important part in power production.

NUCLEAR RESEARCH YIELDS ULTIMATE STANDARD OF LENGTH

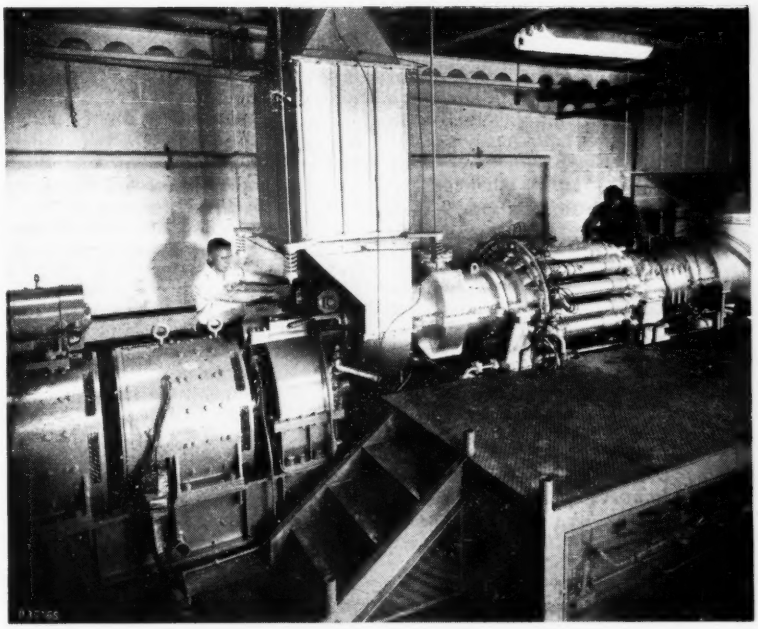
AT LAST THE WORLD has discovered the ultimate in yardsticks, can now throw away the celebrated "meter bar," long guarded so carefully near Paris. As described in Scientific American in August, the length of a wave of pale green light given off by a rare form of mercury transmuted artificially from pure gold in the atomic pile at Oak Ridge becomes the world's new standard. It is accurate to one part in a hundred million! Moreover, it can be reproduced immediately, anytime, anywhere.

The old platinum-iridium meter bar, with its two fine lines spaced at 39.37 inches, has been a constant worry to the world. As early as 1827, a group of natural philosophers meeting in Paris was struck by a disquieting thought; suppose a comet collided with the earth and changed its size or shape. The meter bar, on which all earthly measurements depended, could not be reproduced. During World War I there was great fear that a bomb might destroy the master bar. Many scientists agreed that a new standard was urgently required.

The idea of using the length of a wave of light for the standard is not new. But, nowhere could light be found that was not, to some extent, a mixture of colors and, hence, of wavelengths. How to produce light of one pure color?

Research told scientists of the United States Bureau of Standards that if an isotope of mercury (Hg^{198}) is excited electrically, it would give off the desired pure light. But, unfortunately, mercury in this form does not exist in nature. Then the scientists remembered that a minute quantity of it had been made by Enrico Fermi and others in 1934 by bombarding pure gold with neutrons. Thereupon, the Bureau of Standards purchased 40 oz of pure gold and from it Oak Ridge made about two thousandths of an ounce of the precious mercury. With this, several small lamps have been made and the green light emitted from these lamps now stands alone as the most nearly ideal standard of length that can ever be obtained.

Westinghouse Gas Turbine Goes Into Industrial Service



The Westinghouse 2000-hp gas turbine

THE SAME 2000-hp combustion gas turbine that recently completed more than a thousand hours of test operation at the Westinghouse Turbine Division, Essington, Pa., is about to be shipped to the Mississippi River Fuel Corp. where it will go into service driving a compressor on the natural gas line between Monroe, La. and St. Louis, Mo.

Arrangements have been made through the cooperation of Westinghouse, Mississippi River Fuel, and Ingersoll Rand for a six months trial beginning early in 1949. The gas turbine will drive a centrifugal compressor at 8750 rpm. It will be modified to suit the application with a bed-plate for mounting all components including the compressor.

This is expected to be the first application of a mechanial drive combustion gas turbine in industry in this country. The gas turbine has many advantages which promise wide industrial and transportation use in the future. Producing more power per pound of weight than any other present day power plant, it requires only a simple, inexpensive concrete mat foundation and can be trucked into remote undeveloped regions. It can be set up and made ready to operate in a few hours. It needs no water and very little lubricating oil. Maintenance problems are minimized because of the few moving parts.

The PRACTICAL ENGINEER
DEVOTED TO PLANT OPERATION and MAINTENANCE
A. W. KRAMER, EDITOR

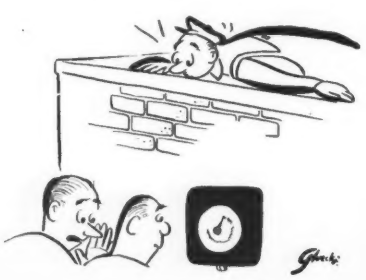
The Grate Seotu Mystery

By GEORGE HOLMAN

BACK IN days when I are leaving first childhood for sterling, silverplated manhood, it are nip and tuck whether "strong back and weak mind, like a fireman," as Boss-man say, when he get smoking hot letter from State Engineer about how come seotu recorders make long, red marks pert near down to zero lines on charts.

"If seotu were dynamite," Boss-man groan, "my fireman, Mickey, couldn't make enough to blow a peephole off—if any of the peepholes had covers on them to blow off. Two per cent. And Mickey burns that coal as clean as a whistle, too. A ton of ash from ten tons of coal, and not a pound of unburned carbon in it. Well, that's efficient enough for me, even if the seotu charts don't satisfy the State Engineer. Them recorders must be off the beat somewhere. Might be they need some more of that there potassium hider —oxide in them."

Previously before this time, maybeso six months, Boss-man have give me job helping stranger-man put in these here recorders. I pester this man to death with questions like: Will Mickey get fired, now that we got seotu recorders to do firing? Why can't seotu recorder make maybe hundred per cent seotu, instead of only twenty, which are as high as charts go? And if banked fires go out, how will seotu recorder light her up again?



I are on top of Boiler

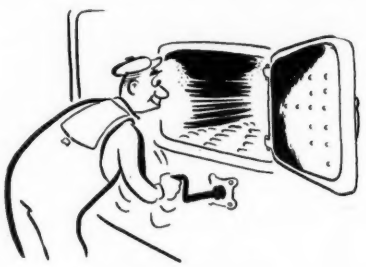
Recorder man laugh silly-like at my senseful cravings for knowledge. But he give me some answers which I understand. I never tell him I are hep that his seotu box are tattletale on fireman. I find that out because I are curiosity impersonated. I get that way hunting weasels, which I never catch because I always look behind me to see what it are the creature stare so at, and he slip away before I get hep he are sizing me up for throat slitting.

After stranger-man test recorders with little handbox full of bottles he call Orsat, and go away, nothing more are done to them except change charts and wind them up each day. For a while they keep seotu at 6 or 7 per cent, then begin to drop. By time State Engineer are due for inspection trip, she are down to 2 per cent, and Boss-man get worry-line on face.

These here seotu recorders are put on two watertube boilers, which are 10 years old, but not on two firetube boilers 20 years old, because firetubers are to be took out and other boilers put in before they blow us sky-high, as Boss-man say. When I show him my drawings for invention for mechanical parachute to come down in from sky-high afterwards, he just sneer: "Another fireman in the makin! You go help Mickey keep them there firetubers from blowin' up till you get your invention patented. Maybe he can raise that there seotu a few points before the State Engineer pays us his visit."

I do everything Mickey say do, except be sure all coke are burn out of ash on chain grate before she hit waterback. He say keep damper open wide so coal will have lots of draft to burn in, and I do it. He say when smoke from chimney get black so people complain about it, just open combustion chamber door so soot will have lots of air to burn in, and I do that, too. Smoke thin out till clouds are seen through it. But seotu go down, not up.

I watch stoker engine and regulate notches took by ratchet gear each time eccentric move her up and down. I break up clinkers and rake fire off level. And between times I find time to do some of my expert flunkey work, like shine brass valve stems and paint pipe lines for State Engineer too look good at when he inspect. Three days before this here inspection day I are on top of boiler patching insulation when Boss-man and Mickey walk up to seotu recorders right under me, and not hep that I are up there.



I crank up the gates

"Tell you what we'll do," Boss-man say to Mickey. "Let's set these things at five per cent on air. Then this here two per cent will give us a seven per cent chart. You can take the next three days off, and I'll let George do the firin'. I'll tell the inspection committee that my regular fireman is off, and I have to get by on what poor help I have. They'll see at once that George is too dumb to fire boilers. That's a good excuse for anything else they find wrong with the way we fire boilers. You say you have a hard time keeping George from dumping live coals into the ashpit? Tsk. Tsk. That's an outright waste of fuel."

At noonhour I get canisters marked KOH

Now, I are teetotally against such fudging with recorder pen to make seotu percentage look higher than she really are. And my face get red as ripe tomato at what Boss-man say about my low per cent wisdom. But I are prideful as all getout that I are to be head fireman for three days. I make up my mind then and there that I will get more seotu out coal than Mickey, or bust—or maybeso bust recorders.

That night I get out books and learn that seotu are made from se, which are wrote with a big C, in coal and otu, which are wrote with big O with a little 2 after it, come from air coal burn in. There being little more than twenty per cent otu in air, there can be only that much seotu in flue gas. Are only two per cent seotu in flue gas, there are eighteen per cent otu which pass through furnace without hitching up to se in coal. To make more seotu in flue gas, I gotta make otu pick up more se in furnace. How are I do this? Answer are simple: Gotta give air more coal.

Next morning when Boss-man tell me I are head fireman, first thing I do are speed up chain grates for full fires under two water tube boilers, and crank up gates to make fuel beds thicker. Right away pop-off valves start simmering. I shut dampers of firetubers, which are hand fired, and use only watertubers. This are much saving on shovel and backwork.

When seotu stay right at seven per cent by chart, I go into stockroom at light noonhour load, and get canisters marked KOH. This are short way to write potassium hydroxide. I have already learn from books. I melt up some of this here KOH in jar filled with water, like recorder man say do to keep her from fussing and fuming and getting hot, and maybeso bust jar, like she might do when water are pour in KOH. I drain old juice out of recorders, and put in this new stuff. That afternoon seotu readings jump to fifteen per cent. Boy! I are fireman out of this world. Or, so I think, till it come back to me that Boss-man and Mickey have set pens five per cent higher than truthsomeness call for.

I put on think cap. Actual ten per cent seotu mean that air still have only half enough coal for burning. Coal bed can't be made thicker, and grates already dump lots of fire into ashpits at waterbacks. I are figuring that more grates could be put into combustion chamber to burn more coal there when bright new idea hit me. No can use more coal for air, then air can be cut down to coal used. Maybeso nobody think of this before? But I do. Boy! Are I brainy!

To cut off some air, I try shutting dampers. But steam pressure go down. I shut ashpit doors. But that don't work either, so open them again. By and by I catch on. Firebed are in A-No. 1 shape. But too much air sneak into furnace beside hoppers, where peephole covers are off, around combustion chamber doors and through brick walls.

Next day I make sheet metal covers for peepholes. I drive flat pieces of iron into slots beside hoppers. I fill lot of cracks with fireclay mud, and smear black goop from stockroom barrel over furnace walls. I are too busy to look at seotu recorder till charts are change next morning. Then I are so bent on showing off before inspector men that I nearly miss seeing recorder pens make only very short lines, or none at all. Before I can make up mind to set pens back to honest readings, Boss-man show up with inspectors. For long time State Engineer watch recorder pens. Then he turn on Boss-man with fire in eyes.

"Your seotu readings are five per cent too high," he roar at Boss-man. "Half the heating value of your fuel is going up the stack as seo. Here's your trouble:" He explain, and swing open a furnace door. "Your fuel bed is too thick. For goodness' sake! Get yourself a fireman. This dumb lout has the numbskull notion that the higher the seotu, the better."

State Engineer tell me dozen times over I should keep seotu inside efficiency zone of chart for good combustion. But next day he are gone, Mickey are back on job, I are back flunkeying and seotu are back to eight or nine per cent, honest reading. As fireman I are fired because I make twenty per cent seotu by chart, which are one hundred per cent efficient combustion.

But here are puzzler: I make twice as much honest seotu as Mickey; I leave fifty times as much unburned carbon in ash as Mickey; and because it are inspection day, I carry much bigger showoff load as Mickey. But I do it with only half the coal he use. Besides, seotu stay lots higher after I fire the three days. For months thereafter this are puzzlement to Boss-man and to Mickey, as well as to jaybirds. Ain't it?

PRACTICAL ENGINEER SECTION

How to Eliminate Vibration in Piping Systems

FUNDAMENTALLY and commonly, vibration in a piping system may be traced to inadequacies of design. This indictment points to such basic errors as incorrect pipe size, unsuitable velocity, poor layout arrangement and/or lack of beneficial accessories. Velocity is of prime importance. Sensible limits based on good usage have been established for most fluids. Pipe sizes may be too big and thereby set up such a low velocity that surges may be extended far back into the piping. In fact, one actual instance is known where surges from an engine were so strong that the water level in the boilers 200 ft away rose and fell so violently that it was impossible to get a true level reading in the gage glasses. On the other hand, pipe that is too small will set up a velocity that exceeds the upper limit of the velocity range and so much resistance to flow will be created that friction loss, or pressure drop, will be excessive. Turbulence may develop because a pipe bend was formed on too long a radius or the actual layout of the system itself may be an invitation for the piping to "flop all over the place."

Vibration, like any other complex problem, is best treated by approaching the problem along the age old avenue of common sense. If you have an effect that does not suit, then the logical procedure is to revise the cause. In this instance, the solution lies in the act of stopping the surge, as explained by F. E. Davenport, Crane Co., Sales Engineer, in a recent issue of *Valve World*. The key to the answer is velocity. A sudden radical lessening of velocity will dissipate the surge. To accomplish this, a suitable surge tank, or receiver, is placed in the affected pipe line, the purpose of which is to kill the pulsations before they can be converted into vibrations.

Precise location of this receiver is of the utmost importance. It should be placed as close to the engine throttle valve, or point of usage,

PRACTICAL ENGINEER SECTION

as is possible. No receiver at all is better than one improperly placed.

When receiver size and location have been fixed, then pipe sizes and layout should be checked. Velocity should be high enough to keep the receiver adequately filled with fluid and pipes as short as consistent with good design. The use of a receiver or surge tank is highly recommended in connection with any reciprocating equipment, such as engines, pumps,

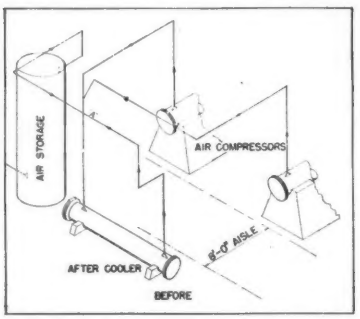


Fig. 1. Original piping installation. Compressors are in parallel and vibrated terrifically

and compressors, where the fluid or fluids involved may be compressed.

To cite an example, an eastern industrial plant required a large volume of compressed air. To supply this demand, an air compressor was installed and later, as the load increased, a second compressor was added in a parallel position about 5 ft away, as shown in Fig. 1. This combined unit was complete with a closed aftercooler and a vertical receiver. 5-in. leads from the compressors were combined to make one 5-in. inlet into the aftercooler and from there to the receiver. It happened that space was so limited and that it was necessary to locate the aftercooler and the receiver about 8 ft in front of the compressors. Unfortunately, an aisle passed between the two sections of this installation making it necessary to bridge this aisle with the piping in order to reach the aftercooler resting on the floor. This piping was unsupported.

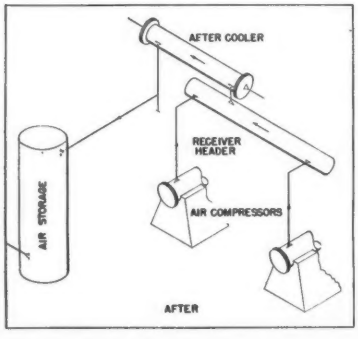


Fig. 2. Revised piping system. Air passes from the compressors into the common receiver-header

The two compressors were of different cylinder sizes and were running at different speeds. When they were running out of step with each other, the piping vibrated quite badly but when they got in step, which happened frequently, the vibration was terrific. Part of this piping (See "A" in Fig. 1) was installed parallel to a partition and was anchored to it in the hope that this would quiet the operation. For a relatively short time, vibrations were fairly mild but finally that infinitesimal residual wiggle, that could not be entirely removed, began to slowly work back to its original intensity. Soon it arrived and the partition became a total loss . . . with the vibration as bad as ever.

A quick check of piping calculations revealed that the pipe size was a little too big for good flow conditions. In other words, the velocity was too slow but this was not considered as being too serious, however, in view of the rather rambling layout of the piping. It was recommended that the discharge of these compressors be connected as closely as possible to a suitable receiver. (See Fig. 2). Flow from the receiver was directly, on a close couple, into the aftercooler and from it to the storage tank. Figure 2 shows the additions to and revisions in the old piping. The new receiver is as close to compressor outlets as conditions permitted. In prescribing its shape, a length was assumed that would couple both compressor outlets into a common header. Once the length was established, the diameter was only a matter of mathematics in relation to the volume desired.

Air passes from the compressors into the common receiver-header where all pulsations are dissipated by the suddenly reduced velocity. Flow from the receiver to the storage tank is again accelerated but the action is uninterrupted and quiet. Trouble-free service for more than a year attests the validity of the corrective design.

Insulating a New 300-hp Scotch Boiler at Supreme Textile Printers

MAJOR PROBLEM of insulating a new 300-hp Scotch marine boiler, to obtain greater boiler efficiency and to prevent waste heat from radiating into the unusually small boiler room, was recently solved at Supreme Textile Printers Inc., Brooklyn, N. Y., by completely covering the boiler shell with a 2-in. thickness of 12 x 18 in. mineral wool blocks and coating the blocks with a ¼-in. layer of insulating cement.

The small size of the 30-by-15-by-15-ft boiler-room, in comparison with the large 21-by-11-by-9½-ft overall size of the boiler, not only made the installation problem a difficult one, but also added to the necessity of the job since the aisle between the boiler and the wall is only about 3 ft and if the boiler were uninsulated, it would present constant threat of burns to employees.

In solving the insulation problem, mineral wool blocks were chosen because their small size made them easy to handle in the confined space and because they would not "shed" while being installed. Shedding would fill the air with small particles of dust and cause bad working conditions.

In applying the insulation, blocks were first temporarily stuck to the shell surface with an adhesive, and were then bound in place with ¾-in. galvanized bands. The large diameter of the shell made it easy to fit the blocks to its curvature. Joints between blocks were staggered so as not to form continuous paths for possible heat leakage. A 1-in. wire netting was secured over the blocks to form a base into which a ¼-in. coat of mineral wool cement was troweled. The cement was applied to seal cracks between the blocks and to give the job a clean, neat appearance.

A definite indication of the increased efficiency gained by insulating the boiler is shown by the following example. Assume the plant operates 250 days per year and the boiler operates at 120 psi and 350 F. Take the values for bare heat loss from Kent, page 3-64 and for insulated heat loss from Kent, page 3-67. Area of shell of 300-hp Titusville oil-fired Scotch marine boiler is 570 sq ft.

bare heat loss.....
2,729,160,000 Btu per yr (798 Btu per sq ft x 570 sq ft x 24 hr per day x 250 days per yr)

insulated heat loss.....
218,880,000 Btu per yer (64 Btu per sq ft x 570 sq ft x 24 hr per day x 250 days per yr)

savings .....
2,510,280,000 Btu per yr (2,729,160,000 — 218,880,000)

Assuming the use of 145,000 Btu per gal oil and an operating efficiency of 60 per cent the savings in fuel is 28,854 gal per yr. [2,510,280,000 ÷ (145,000 x 0.6)]

The Scotch marine boiler was chosen for this job because it could

Workman applying insulation to a 300-hp Scotch Boiler at Supreme Textile Printers

PRACTICAL ENGINEER SECTION

deliver the extra steam capacity necessitated by increased production of finished textiles, and at the same time fit into the space available. The plant now operates two and three shifts and requires extra steam for dyeing, printing, framing, ageing, and other finishing operations. The Scotch-marine type boiler is self contained, requires no pit or brick base and hence is well suited to this application.

The boiler was installed by Warner J. Sherb, Inc., of New York, power plant and consulting engineers. It has been in operation a little over five weeks, has passed all preliminary tests, and promises to give excellent future service.

STEAM SUPPLY CHANGES IN JAM FACTORY SAVE 33 PER CENT IN FUEL

By JAMES O. G. GIBBONS

THE ACCOMPANYING DIAGRAMS illustrate the changes made in the steam supply at a British Jam Factory in accordance with the recommendations of the engineers representing the Ministry of Fuel and Power.

When the plant was first inspected, it was found that the boiler which had lost most of its lagging was providing an average steam load of 1630 lb per hr at a pressure of 80 psi and consuming 6¾ tons of coal in the summer and 7½ tons in the winter.

About 1080 lb of steam per hour was used for heating six steam jacketed boiling pans, none of which were lagged. During the cold weather 250 lb of steam per hour was used for heating the warehouse. The fruit pulper was only operated a few hours a week, but when in use it took 600 lb of steam per hour.

Steam was also required for washing jars which took 480 lb per hour when the water was cold but this fell to 150 lb per hour when working temperature was reached.

The boiler was lagged, descaled, and fitted with a damper, and in addition the fireman was given some lessons in proper firing.

After that was done consideration was given to the heat wasted in the condensate, and since the injector could not handle hot water, it was discarded and a boiler-feed pump installed. A feedwater heating tank of about 150 gal capacity was installed and insulated, and the exhaust steam from the boiler-feed pump discharged into this tank. The boiling pans were individually trapped and vented, and the condensate discharged into the new feedwater tank.

The blowoff from the pans was connected to the jar washing tank, and this tank was furnished with thermostatic control which maintained the temperature at 120 F.

Exhaust steam made the feedwater so hot that a considerable amount of steam was blown to the atmosphere; a thermoflow valve was installed which maintained the feedwater at 180 F and allowed the excess condensate to flow to the jar washing tank.

To prevent trouble from live steam should a trap fail, an orifice was installed in the connection to the jar washing tank. After these changes had been made not only was the boiler feedwater maintained at 180 F but the steam make-up for the jar washing tank was reduced from 150 lb to 50 lb an hour.

The final result was that steam consumption was reduced from 1630 lb per hr to 1200 lb per hr and the output of the plant increased. The fuel saved was 33 per cent in winter and 37 per cent in summer. The cost of the changes in pound sterling was 485. And the saving in coal alone was 360 pounds sterling per annum, or about $1440.

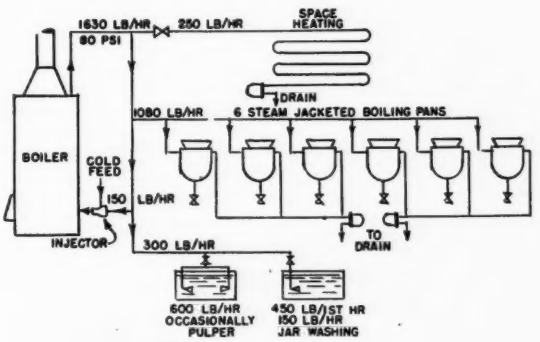


Fig. 1. Diagram of steam system and amounts of steam used before changes were made

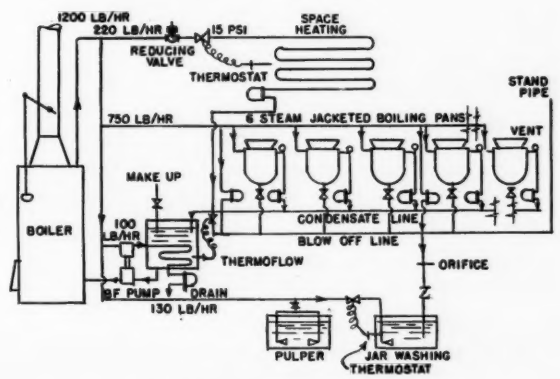
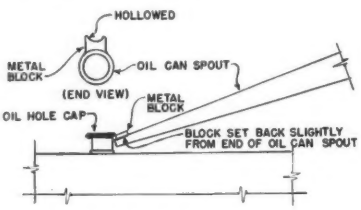


Fig. 2. Diagram of system shown in Fig. 1 after changes were made

PRACTICAL HINTS AND KINKS

OILING CAP LIFTER

BY SOLDERING or brazing a small metal block onto the end of an oil can spout, as shown in the accompanying illustration, much time and effort can be saved in lifting the caps of oil cups and oiling holes.



Details of oil cap lifter

HANDY MULTI-PURPOSE CLAMPS

THE MULTI-PURPOSE clamps shown in the accompanying photographs are proving very useful in servicing large armatures and commutators.

These clamps which are made by Marman Products Co., Inc., of Inglewood, California, have been adopted by several large electrical service shops to pull coils into place when re-winding armatures. In the past it has been necessary to use a wire banding machine to accomplish this purpose—an expensive and time consuming process. By simply wrapping the multi-purpose clamp around each layer of coils and tightening the locking device and take-up screw, intense pressure can be applied to force coils into position for final banding. It is estimated that as much as six hours are saved on large jobs.

The clamp is also used to great advantage to hold commutator segments while assembling and processing. This again does away with the necessity of using a banding machine and greatly facilitates the operation.

This versatile clamp is designed for use in any situation where a wrap-around clamp action is required. It permits clamping of many different shapes and objects. A large diametrical take-up range is provided and pressure can be instantly released by backing off locking screw one-half turn.

The clamp consists of a tough, inter-changeable, stainless steel strap furnished in 1½ to 2 in. width of any desired length, a square swivel assembly and take-up and locking screws of cold-rolled steel.

THE IMPORTANCE OF A GOOD GROUND

By W. E. WARNER

THE IMPORTANCE of a good ground in new electrical installations is well recognized. Often, however, the efficiency of a ground connection deteriorates, grounding connections may corrode and it is possible that the electrical system may be extended and the original ground used without its capacity being extended. Too often if a conduit system has been efficiently grounded further ground conductors may be connected to it, with the result that the main ground is too small for the load. Under these conditions, if a ground does develop, the fuses may not blow but the ground current may be only partially conducted to ground, with the result that the ground conductor heats and may cause a fire and earthed parts become alive. Live grounded parts, besides being dangerous, may cause a backfeed to other electrical equipment. The grounding system should be doubly examined at intervals, tests with a megger or test lamp are not entirely reliable as any ground conductor may be grounded at some point along its length, by masonry, etc. This may cause it to show a fairly good test. There is always the possibility of mechanical damage or corrosion of ground connections, and to detect these inspection is necessary.

AN INGENIOUS WAY OF FINDING CAM ANGLES

By CLIFFORD T. BOWER

A DEUTZ Diesel engine of German manufacture had been waterlogged due to floods for about two months. It was decided to salvage the engine and restore it to working order. Everything about the engine was found to be in workable condition except the camshaft which ran out in the open alongside the crankcase; this was badly eaten away with corrosion and it was decided to measure it up and make drawings so that a new one could be manufactured.

By mounting the camshaft sections in a pair of vee blocks it was possible to ascertain the cam profiles by using a dial gage and noting the amount of lift for a given number of degrees of rotation. It was found impossible to accurately locate the exact center line of the cam peaks owing to wear and corrosion because in a rotation of about 4 deg the dial gage movement was erratic.

The device A in the sketch was made and enabled the angular displacement of the cam peaks to be located within a ¼ deg relative to each other. The device is piece of ⅛ in. thick aluminum sheet, the cam profile B being carefully laid out relative to the cam center line C and then accurately sawn and filed so that the two fit together. Tongue D has both sides made parallel to

Fig 1. The Marman Multi-Purpose Clamp can be used to great advantage for holding commutator segments during assembly operations in a motor rebuilding shop

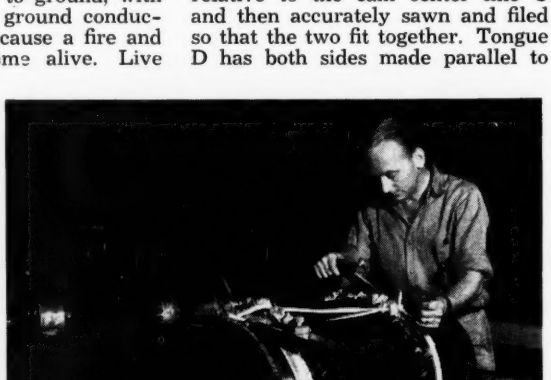
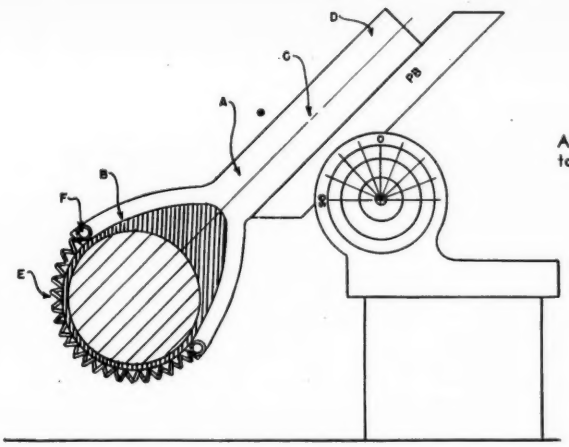


Fig. 2. The Multi-Purpose Clamp simplifies armature re-winding by eliminating the need for a wire banding machine. Because of the ease with which this clamp forces coils into position, as much as six hours can be saved on large jobs



Arrangement devised to determine cam angles

the cam centre line. The device is merely placed on the cam and held there by a pair of light springs, one of which is shown at E, engaging a pin F driven through the aluminum. Strong rubber bands will do the job equally well.

Using a pair of bolt holes in the cam shaft connecting flange as a datum point, the device can be placed on each cam in turn and its angular position relative to the datum point can be ascertained by means of a protractor blade, PB, contacting the side of tongue D.

WATER IN STOKER ASH PITS REMOVED BY STEAM SYPHON

By GEORGE G. AVANT

WE HAVE several steam syphons in our ash pits to remove the water used in quenching the clinkers in the stoker ash pits. We make these syphons from pipe fittings and they are of short life due to the abrasive action of the fine ash that gets mixed with the water. At times the water gets somewhat hot and this makes more trouble when the syphons are started.

As shown in the accompanying sketch the steam valve is near the floor level, so that the operator does not have to climb down into the ash pit to operate the syphon. In the discharge line we add a tee just above the syphon. A valve is connected as shown, the hand wheel on this valve extending up through the floor grating. When water accumulates in the sump and the operator wants to pump it out the procedure is as follows; Open valve "A," then open steam valve "B." As soon as water is seen to pass through valve "A," this valve is closed. The operator then knows that the syphon is working. In the event that the water is somewhat hot then valve "A" is left slightly open and the syphon will pick up the water and continue to remove all the water.

With this arrangement I have removed water that was so hot that I could not put my hand into it.

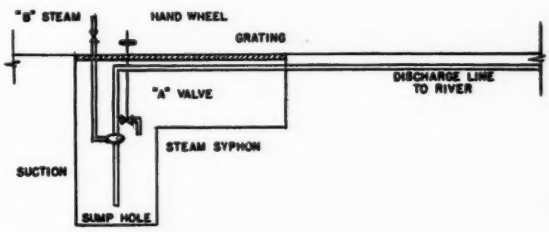


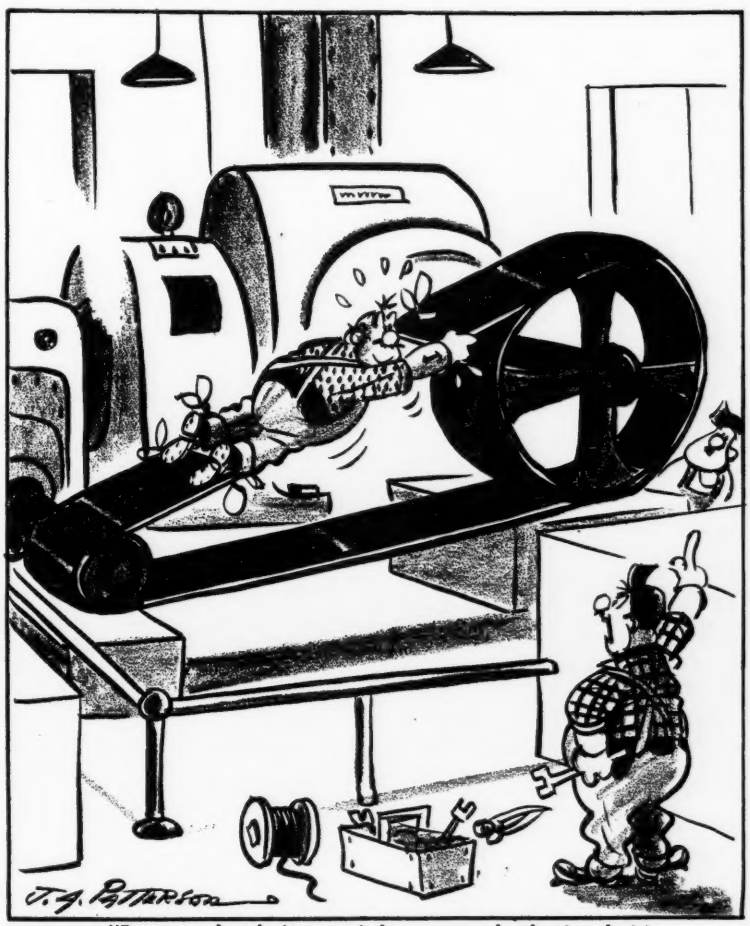
Diagram showing the arrangement of a steam syphon for removing water from stoker ash pits

PRACTICAL ENGINEER SECTION

LAZINESS, MOTHER OF INVENTION

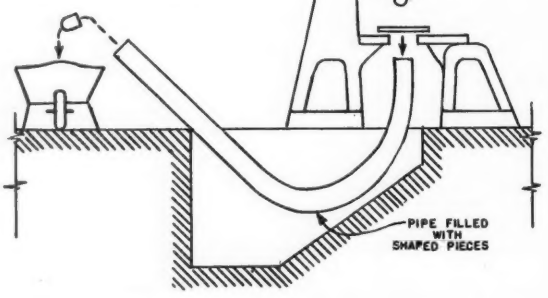
By WILBUR G. HUDSON

AT A CLEVELAND shell manufacturing plant during the war, I observed a battery of 12 punch presses. Brass discs about 5 in. diameter by ½ in. thick were placed on the die and the punch descended to form them into a cup about the shape, size, and thickness of a table tumbler. These shot down into a pit from which a man at each press shovelled them up into a wheelbarrow by which they were trans-



"Because that belt wasn't long enough, that's why!"

PRACTICAL ENGINEER SECTION



Conveyor rigged up out of a length of leader pipe speeds production

ported to the next operation which formed them into 30 mm shell casings.

One of the men, no doubt tiring of the shovelling job, had rigged up a length of 4 in. leader pipe beneath the die. As each formed piece shot into one end of the bent pipe, it shot out one into the wheelbarrow. All twelve presses were promptly so equipped, and one man did the job of twelve. The conveying pipe was always full of shaped pieces. When one shot in at the receiving end, another popped out into the wheelbarrow.

LAYING OUT FABRICATED MITRED ELBOWS

By LESLIE H. HOUSEL

HERE IS A QUICK and easy way to lay out those fabricated, mitred elbows.

Select an appropriate radius; also the number of segments desired to make the bend. The number of segments plus one, equals the number of welds. Divide the angle of the bend by this number. The result is the included angle of each segment. Remember that the angle of the tangent ends combined, equals the angle of one segment.

A good rule for the radius is—Radius equals one pipe diameter.

The angle you have computed is also the angle the O.D. of a segment makes with a tangent or another segment. See examples in accompanying illustrations.

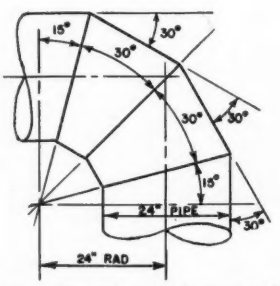


Fig. 1. Desired—a 90 degree bend
2 segments—24 inch pipe
2 plus 1 equals 3 welds
90/3 equa's 30 degrees
30/2 equals 15 degrees

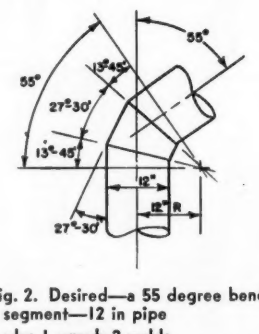


Fig. 2. Desired—a 55 degree bend
1 segment—12 in pipe
1 plus 1 equals 2 welds
55/2 equals 27 degrees 30 min.
27-30/2 equals 13 degrees 45 min.

LETTERS AND COMMENTS

WHAT DOES THE VELOCITY OF LIGHT REALLY MEAN?

IN READING the articles which appear in the Atomics Section, I have been thinking about certain aspects of radiation on which I am not quite clear. One of the questions, which I have discussed with several of my friends but without much success, pertains to the velocity of electromagnetic radiation—also the velocity of wave propagation in an electric circuit. This velocity is generally stated as being 186,000 miles per second.

In reading through books on physics, I have never been able to find any theory or explanation as to why this velocity is the value it is.

As I recall it, the weight of the electron is about one eighteen-hundredth of that of the hydrogen atom and I have been wondering if, say the weight of the electron was more or less than the generally accepted weight, whether there would be any difference in the rate of wave propagation in the electric circuit or of the velocity of light.

Can you give me any information on this question?

Atlanta, Ga. S. H. SMITH

Editor's Note—Mr. Smith raises an interesting question. At first I was not quite certain that I understood what he meant—whether he wondered why the velocity of electromagnetic wave propagation was 186,000 miles per second and not 200,000 or say 100,000 miles per second, or whether he was concerned purely with the relation between the velocity of wave propagation and other constants such as the mass of the electron.

After thinking the problem over, I assume it is the latter he has in mind, because to mean anything, *velocity* must be related to matter in one way or another. Simply to think of velocity of wave propagation in space is meaningless, because the conception of space itself is meaningless in the absence of matter.

The velocity of light is really nothing more than a universal constant, expressing the relation between mass and energy. As is well known, in 1905 Einstein in the course of his studies in black body radiation, stated that mass and energy were equivalent, that the amount of energy E, equivalent to a mass M, was given by the equation

$$E = MC^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots 1$$

where C is the velocity of light. (2.997×10^{10} cm per sec) Thus

$$C^2 = \frac{E}{M} \quad \ldots\ldots\ldots\ldots\ldots\ldots 2$$

$$C = \sqrt{\frac{E}{M}} \quad \ldots\ldots\ldots\ldots\ldots\ldots 3$$

From this equation, it can be seen that if C is a constant, a variation in either E or M would require a corresponding variation in the other. And since C *is* a constant—2.997×10^{10} cm per sec—any variation in mass implies a variation in E.

Now it will be seen that Mr. Smith's thought in regard to the effect of the mass of the electron has been answered by equation 3. He wonders if the weight of the electron was more, or less, than the generally accepted weight (roughly 1/1800 that of the proton) whether there would be any difference in the velocity of propagation of electromagnetic radiation. Equation 3 tells him the answer is "no."

In other words, the velocity of light, or of any electromagnetic radiation, is a constant expressing the relationship between mass and energy.

The absolute velocity of propagation, 2.997×10^{10} cm refers only to the velocity in free space. Since, in its passage through matter, energy is absorbed by the atoms constituting such matter, the velocity in matter, or of waves traveling along conductors will be less than that which obtains in vacuo. It is this slowing up of the wave which accounts for

the phenomenon of refraction in both electrical and optical systems.

This change in velocity of propagation as a consequence of the passage of electric waves through matter, has no bearing on this particular question since it is concerned with the absolute velocity of light.

This is about as far as we can go in understanding the velocity of electromagnetic radiation. It is something like Planck's constant. In the quantum theory the relation between the energy of a system and its frequency is given by the equation

$$E = hv$$

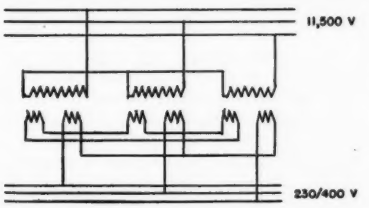
where v is the frequency and h is a universal constant. This constant was determined by Max Planck to be 6.55×10^{-10} erg-seconds. Now, one may ask, what is the physical meaning of the constant, h? Or why is it 6.55×10^{-10} and not something else? The answer to this question is that h has no physical meaning, it cannot be interpreted in terms familiar to our senses. It merely expresses a universal relationship between energy and frequency and cannot be expressed solely in terms of older concepts of physics, any more than the dimensions of, say, a dielectric constant can be expressed in terms of length, mass and time.—A. W. Kramer

HARMONIC VOLTAGES CAN BE TROUBLESOME

IT OCCURRED to me that the readers of POWER GENERATION might be interested in my experiences with third harmonic voltages. A small town is supplied with electricity from the power station of my company via a five mile 11,500-v overhead line with an ungrounded neutral. The town authorities had installed a bank of 3 single-phase transformers, 75 kva each, to step down the 11,500-v supply to 230/400-v 3-phase 4-wire.

Since the voltage rating of each transformer was 6,600-v, plus or minus 5 percent, to 440/220-v, the bank had to be connected in star on the high voltage as well as on the low voltage side. The low voltage side consists of two windings which were connected in parallel in order to obtain 230-v between phase and neutral, and 400-v between phases. No other transformer was obtainable at the time.

Shortly after the supply was switched on, complaints started coming in that lamps and radios were burning out. A voltage check, with an ordinary portable shop voltmeter, showed 230-v between phase and neutral, and 420-v between phases. These values did not seem to agree with each other so they were checked with an a-c/d-c switchboard voltmeter. This instrument revealed 255-v and 420-v respectively. The explanation for the



Showing how low voltage transformers were re-connected to eliminate 3rd harmonics

damage was obvious; a third harmonic voltage component due to the star-star connection.

In order to improve the position temporarily as far as possible, a 3-phase 11,500/500-v star-delta transformer was connected in parallel with the existing bank on the 11,500-v side. This brought the voltages down to 240/405-v. The third harmonic voltage was not completely eliminated, due to the fact that the capacity of the additional transformer was only 75 kva, compared with 225 kva of the bank.

In order to suppress the third harmonic completely, without the use of an additional transformer, the two low voltage windings of each of the 3 transformers of the bank were separated; the ends of one winding were brought to the outside through two additional bushings in each transformer cover. These 3 windings were then connected in series to form a delta. The other portion of the low voltage winding was connected in star as before and now gave 230/400-v.

The capacity of the bank was reduced from 225 kva to about 120 kva through the above alteration. Since the peak load is only about 65 kva, this is not of much consequence.

Cape Province,
South Africa — W. NEUMAN

WHY THE BOILER ACTED QUEER

By ALBERT H. MOULTON

IN THE POWER PLANT of a public utility company that had been in service for a good many years, one of four 3-drum boilers began to act a little "queer." These were longitudinal drums and each was equipped with a safety valve. This particular boiler, like the others, was equipped with a superheater and a float type regulator. Feedwater was supplied by turbine-driven centrifugal boiler feed pumps, with excess pressure governors. There was ample capacity to supply all boilers at full steaming capacity. The load was fluctuating at times, but was mostly steady and heavy during the "peaks."

All the boilers were stoker fired with under fire forced draft and chimney up-take draft. With light or moderate steam output, up to about 100 per cent rating, everything was fine: water level steady and normal height. However, as the load increased from there on, the water level dropped fast, and at 200 per cent rating the water just disappeared and stayed out of sight even with 60 or more pounds excess pressure. This boiler used to carry up to 275 per cent rating during peak loads for hours at a time without giving any trouble and 35 to 50 lb excess pressure was usually enough to supply all boilers at full load.

PRACTICAL ENGINEER SECTION

Operating pressure was 195 psig with the safety valve set at 205 psig. The water column and feedwater regulator were both connected to this drum, but by separate connections. There was also an equalizer connection for both steam and water, running from the other outside drum as shown in the accompanying diagram. With this type of regulator the water level is supposed to fall as the load comes on; after the "swell" goes off the float reaches a point where the regulator valve is wide open, then it should stay in sight. It has been said, "Trust in the Lord, but keep water in the glass on your own account!" If it fails to do this, the regulator must be cut out or the load reduced to where it can take care of it. In this case cutting the regulator did not bring the water back in sight until the load dropped off.

At the high rating the safety valve on this drum would blow at a little below the blowing point of the other safety valves, as shown by this boiler's steam gage taking pressure from a collector pipe.

In normal operation when a boiler stops steaming, the water level falls due to the "shrink" caused by less steam bubbles in the water and an increase in the steam pressure. In this case, just the opposite happened. As the fan slowed down and most of the load went off, the water would come back with a rush; sometimes to the top of the glass. If the pressure

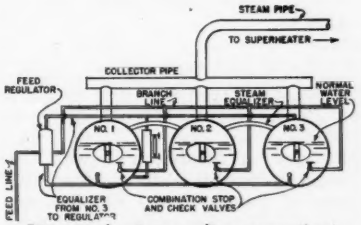


Diagram showing equalizer connections

went up to the blowing point, it would be the safety valve on one of the other drums which would blow first!

This boiler, like the others in this plant, was taken out of service once a year for cleaning, inspection, overhauling tubes, etc. It was during one

of these inspections that the Chief Engineer discovered the real cause of the trouble. Looking into the dry pipe in this drum, he noticed that some of the slots were nearly closed up by incrustation deposited there by the boiler water. The deposit had come on so gradually that it had escaped notice up to that time. Inspections of the other drums revealed high water marks, way above the normal level. The water mark was also up in some of the dry pipes, but not nearly as high as in this drum.

The explanation for this strange behavior is that when the steaming rate got up to 200 per cent rating the steam outlets through the dry pipe and drum equalizers were not big enough to allow free escape of steam. Acting like a partly closed stop valve, and so causing an accumulation of about 2 lb more pressure in this drum, this extra pressure forced the water level down in this drum and up in the others until a hydraulic balance was reached between the drums. This caused the safety valve on this drum to blow first; when the blowing off pressure was at this rating.

Questions and Answers

Question No. 429

HE WANTS HELP ON POWER PLANT MAINTENANCE SCHEDULES

A SHORT TIME ago the problem of setting up a maintenance schedule for the power plant where I work was handed to me. So far I have made little progress. Can you give me some suggestions, or tell me where information can be obtained, on how to go at it.

The plant is a public utility central station having a rated capacity of 27,500 kw. There are four turbine generators and four pulverized-coal-fired boilers, with all the attendant auxiliaries.

At present, the station operates as a base load station at rated capacity, in a system with small reserve capacity.

Ohio F. T. L.

Editor's Note:—To get F.T.L. started we have referred him first to a fine article entitled "Maintenance on Schedule" by Andrew L. Freeman, Manager of Minnkota Power Cooperative published in the May 1943 issue of POWER PLANT ENGINEERING. Also in the September 1943 issue was a special section on war time training of plant personnel and included in that was a discussion of the job breakdown plan for maintenance used by the Idaho Power Company. This plan was particularly effective on maintenance work for reasons explained by E. A. Woodhead, Superintendent of Power Plants and the article showed two typical job breakdown sheets giving a good idea of how it is done.

In addition, we have, of course, referred F.T.L. to a number of the electric utility companies that we know have good maintenance scheduling. But additional comments from readers will be most welcome for the whole problem of maintenance scheduling under present low reserve conditions is just as important in many ways as it was during the war.

Question No. 430

WHO KNOWS ABOUT INCENTIVE BONUS SYSTEM FOR AMMONIA REFRIGERATION PLANT?

CAN ANY Q&A reader give me information on how an incentive bonus system can be worked out for a medium-sized ammonia refrigeration plant? Or tell me of any such plants that have incentive bonus systems for the operators, so that I may ask them for further details?

This may seem like a strange question but here is the reason for it. The ammonia refrigeration plant in question requires several operators and assistants and is part of a large manufacturing plant. The management of the factory wants to investigate the feasibility of an incentive bonus system for all the employees of the plant. Now in most cases, in the production processes, that is no problem, because there are ways of measuring employee production. But when you come to something like a refrigeration plant, just how can you measure the production of the operators, in connection with an incentive bonus system? And just how should they be related to the other workers in the plant in such a system?

Chicago, Ill. F.D.

Question No. 431

WILL A RECTIFIER SOLVE THIS PROBLEM?

I AM STUCK with several new d-c motors, 1 hp and ¾ hp, 230-v. The ¾ hp motor is for a potato peeler and operates on 230-v d-c, 3.25 amps, 1725 rpm, and has 3 leads marked "A", "L", and "F". The other motor is for a bench grinder and has a push button start and stop switch.

Would a rectifier solve my problem and if so, what voltage would they require, 110-v or, 220-v single phase, three phase, or what? I would appreciate any information which the Q & A readers can offer.

Mt. Angel, Oregon B. M. M.

Answer No. 417

WHAT SUPPORTS THE WEIGHT OF THE PISTON?

Depends on Type, Says Elbert

THE SUPPORT of the piston depends upon the type of piston—whether it is a built-up piston, consisting of a spider, bull ring, follower plate, and rings; or whether the piston is a solid cast piston consisting of the piston body and the rings.

With the built-up type piston without a tail-piece, the weight is supported by the bull ring and the piston rings, also by the piston-rod packing gland.

With a solid cast piston without the tail-piece, the weight is supported by the rings and the piston rod packing gland.

Years ago they experimented with forged steel-plate pistons having broad composition shoes riveted to the lower circumference, the shoes projecting into recesses formed in the heads.

Then they tried pistons with a steam pocket underneath them, into which steam was admitted through a small hollow tailrod. These experiments were not very practical and were not continued.

Irvington, N. J. CHARLES H. ELBERT

Answer No. 399

SHOULD 115-V EXTENSION LIGHTS BE USED INSIDE BOILER DRUMS?

EVER SINCE R.H.N. asked this question in the November 1947 issue, the brethren have been pro-ing and con-ing it. R.H.N. said his own electrical engineers, in designing a new power plant, felt that 115v was safe enough if proper precautions are taken, but that he had always dis-

agreed with this and recommended 32v for extension lights and portable tools in his new plant. Many engineers supported R.H.N. in this stand. Moreover, while the discussion was going on, some good comments came to light from the National Safety Council. Although there is no inflexible rule, the Council seems to recommend 32v or even 6v, but at the same time stresses the need for suitable safety precautions in any case.

On the other hand, many engineers seemed to feel that it was a question of safety precautions rather than voltage and that 115 was as safe as anything if the worker observed the precautions and if proper equipment was used.

However, here is a recent and very good comment from a man who says the 32-v circuit may still have one wire from which the potential to ground may be 115v and that the most important safety measure, whatever the voltage, is to use a three-wire hook-up and a continuity tester and make sure.

Safest Way Is To Use 3-Wire System and Continuity Tester

DISCUSSION of the use of 115-v extension lights serves a valuable purpose; because, too frequently, lighting voltages are treated as harmless by maintenance men.

Actually, it is not the voltage that causes injury; it is the current. The current, of course, depends on the resistance and the voltage. It has been estimated that any current over 0.2 milliamperes is dangerous to human life. When dry, and on a wooden floor, the body resistance averages at least 50,000 ohms, and together with the floor resistance, makes 115 v relatively safe. But damp hands or feet can make the body resistance negligible. Steel or concrete floors, or earth, are relatively good conductors; so that under many situations in boiler repair work, even 32 v must be treated with caution.

When 32 v is supplied from a transformer, there is always the possibility that one of the wires inside the transformer is "grounded" to the supply voltage of 115 (or 230) v. In such a case, the potential between the two wires will still be 32 v, but the potential between either wire and the floor will be 115. An a.c. 32-v system must be treated with the same respect as a 115-v arrangement.

The most important safety measure that can be taken on portable cords used with lamps or portable drills, and so on, is a three-wire hook-up, as shown in Fig. 1. The third wire is grounded at the outlet, and attached to the external metal portion of the lamp housing or the portable tool.

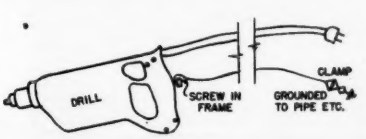


Fig. 1. Diagram by Podell showing how 3-wire system is made up for portable tools or extension lights

Various methods of attaching the third wire to the outlet frame are in use. The simplest is to terminate the third wire in a rubber-covered clamp, which is attached to one of the outlet screws or a nearby pipe. A preferred method is to use three-way polarized plugs and outlets, Fig. 2, particularly if the outlet itself is not grounded. The use of the third wire will blow the fuse the instant the tool becomes "grounded," and will protect the operator.

However, with all precautions taken in advance, equipment and lines should be regularly checked with a continuity tests, Fig. 3. The quotation, "Eternal Vigilance . . . " applies to the use of electrical portable tools and fixtures. By use of a continuity tester, it is possbile to check for grounds; connecting one end of the tester to the frame, and the other end alternately to each of the wires in the cord—test with the tool switch on and off. It is thus easy to detect grounds and to make sure that the third wire is connected.

In this connection, it should be noted that the use of two fuses on a 115-v circuit is not as safe as one fuse on the "hot" side only. With two fuses, it is possible for a short circuit to blow the neutral side, leaving the "hot" side still connected. The one fuse method is standard practice but in many older plants, the 115- cutouts still have a fuse on the neutral wire.

One answer to the question comments on the wide use of 115 v in laundries, and by women and children in washing machines, water heaters, and bathrooms. Such widespread use does not indicate safety, but negligence and unfamiliarity with accident reports. The daily reports always contain an item indicating fatal accidents to children and others working in such surroundings.

Some of the more unusual accidents with 115 v are as follows:

A truckman picking up a floor scraper machine, for return to the hardware store, forgot to remove the plug from the outlet. As he stepped on the grass, he received a fatal shock from the machine which was grounded.

A plumber was electrocuted in removing the fuses from a box in the cellar. He forgot to disconnect the switch.

Important Note: — When removing a blown cartridge fuse, the full line voltage is across the fuse terminals unless the switch (where there is one) is open. On the 30-amp size, the fuse terminals are too close to avoid touching one or both terminals. A concrete floor, because of moisture absorbed, is equivalent to a steel floor in danger. A wooden floor should be placed adjacent to all fuse and switch boxes. Fuse pullers are necessary, particularly on the small size fuses.

A maintenance man was found dead in the plant on a Monday morning. He apparently had been working with a portable drill on the previous Saturday, and received a shock from the tool on a concrete floor. Whether he was killed by the shock alone or from falling was not ascertained.

Some of the most typical accident reports are based on the use of grounded water heaters, radios, or fixtures in bathrooms, and laundries.

All of the above accidents which occurred from "grounds" would have been avoided if the three-wire system, outlined above, had been used, and if periodic continuity checks had been made.

New York, N. Y. HOWARD I. PODELL

PRACTICAL ENGINEER SECTION

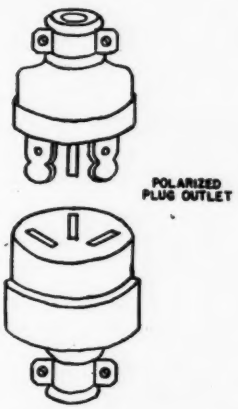


Fig. 2. Polarized plug outlet

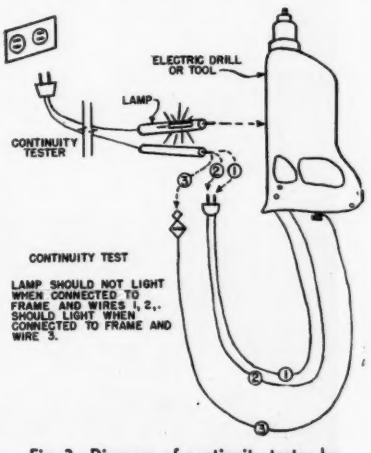

ELECTRIC DRILL OR TOOL
LAMP
CONTINUITY TESTER
CONTINUITY TEST
LAMP SHOULD NOT LIGHT WHEN CONNECTED TO FRAME AND WIRES 1, 2,. SHOULD LIGHT WHEN CONNECTED TO FRAME AND WIRE 3.

Fig. 3. Diagram of continuity tester by Podell

TABLE OF COMMONLY USED CONSTANTS

Table of Commonly Used Constants

Constant	Numerical Value	Logarithm	Constant	Numerical Value	Logarithm
π	3.141593	0.49715	Weight in pounds of:		
2π	6.283185	0.79818	Water column, 1"×1"×1 ft.	0.4335	$\bar{1}$.63699
$\pi \div 4$	0.785398	$\bar{1}$.89509	1 U.S. gallon of water, 39.1°F.	8.34	0.92117
π^2	9.869604	0.99430	1 cu. ft. of water, 39.1° F...	62.4245	1.79535
π^3	31.006277	1.49145	1 cu. in. of water, 39.1° F...	0.0361	$\bar{2}$.55751
$1 \div \pi$	0.318310	$\bar{1}$.50285	1 cu. ft. of air, 32° F., atmospheric pressure	0.08073	$\bar{2}$.90703
$1 \div \pi^2$	0.101321	$\bar{1}$.00570	Volume in cu. ft. of:		
$1 \div \pi^3$	0.032252	$\bar{2}$.50855	1 pound of water, 39.1° F...	0.01602	$\bar{2}$.20465
$\sqrt{\pi}$	1.772454	0.24858	1 pound of air, 32° F., atmospheric pressure	12.387	1.09297
$\sqrt[3]{\pi}$	1.464592	0.16572	Volume in gallons of 1 pound of water, 39.1° F.....	0.1199	$\bar{1}$.07883
g	32.16	1.50732	Volume in cu. in. of 1 pound of water, 39.1° F.....	27.70	1.44249
g^2	1034.266	3.01463	One cubic ft. in gallons	7.4805	0.87393
$2g$	64.32	1.80835	Atmospheric pressure in pounds per sq. in.....	14.696	1.16720
$1 \div 2g$	0.01555	$\bar{2}$.19165			
$\sqrt{2g}$	8.01998	0.90417			
$1 \div \sqrt{g}$	0.17634	$\bar{1}$.24635			
$\pi \div \sqrt{g}$	0.55399	$\bar{1}$.74350			
e	2.71828	0.43429			

Useful Constants Multiplied and Divided by 1 to 10

Constant	Multiplied by:							
	2	3	4	5	6	7	8	9
0.7854	1.5708	2.3562	3.1416	3.9270	4.7124	5.4978	6.2832	7.0686
3.1416	6.2832	9.4248	12.566	15.708	18.850	21.991	25.133	28.274
14.7	29.4	44.1	58.8	73.5	88.2	102.9	117.6	132.3
32.16	64.32	96.48	128.64	160.80	192.96	225.12	257.28	289.44
64.32	128.64	192.96	257.28	321.60	385.92	450.24	514.56	578.88
144	288	432	576	720	864	1,008	1,152	1,296
778	1,556	2,334	3,112	3,890	4,668	5,446	6,224	7,002
1,728	3,456	5,184	6,912	8,640	10,368	12,096	13,824	15,552
33,000	66,000	99,000	132,000	165,000	198,000	231,000	264,000	297,000
Constant	Divided by:							
	2	3	4	5	6	7	8	9
0.7854	0.3927	0.2618	0.1964	0.1571	0.1309	0.1122	0.0982	0.0873
3.1416	1.5708	1.0472	0.7854	0.6283	0.5236	0.4488	0.3927	0.3490
14.7	7.350	4.900	3.625	2.940	2.450	2.100	1.838	1.633
32.16	16.080	10.720	8.040	6.432	5.360	4.594	4.020	3.573
64.32	32.160	21.440	16.080	12.864	10.720	9.189	8.040	7.147
144	72	48	36	28.800	24	20.571	18	16
778	389	259.33	194.50	155.60	129.67	111.14	97.25	86.44
1,728	864	576	432	345.60	288	246.86	216	192
33,000	16,500	11,000	8250	6600	5500	4714.3	4125	3666.7

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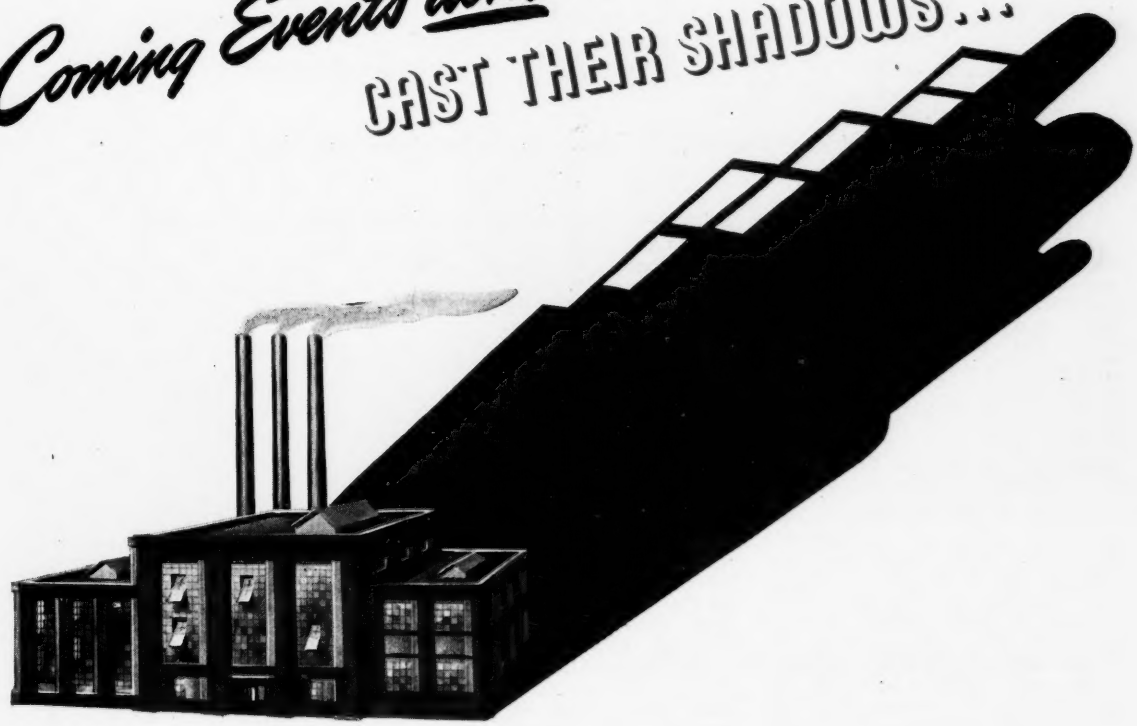
Coming Events don't always CAST THEIR SHADOWS...



Particularly in the Power Plant Field.

Plant Outage, for instance, can and usually does strike at any time *without warning.* But how many or *how few* shut-downs you have may depend entirely on the effectiveness of your water conditioning service.

Correct water conditioning is a matter of careful and scientific control.

W. H. & L. D. BETZ is an organization of engineers and chemists specializing in the solution of all industrial water problems. Years of experience have made Betz water conditioning service scientifically correct . . . complete . . . economical. Our staff of engineers will welcome the opportunity of discussing your boiler water problems . . . W. H. & L. D. BETZ, Gillingham and Worth Sts., Philadelphia 24, Pa. In Canada: Betz Laboratories Limited, Montreal 1.

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Consider Steam for Air Conditioning

Much post-war air conditioning tonnage large enough to justify use of purchased steam as energy source for refrigeration . . . Performance data on absorption systems, steam jet refrigeration, condensing and non-condensing steam turbine-driven centrifugal compressors, based on installations served by New York Steam Corp. in New York City . . . Cooling towers . . . If you need plant air conditioning, consider how you can improve power plant heat balance by these methods . . . If you can purchase both steam and electricity, make careful economic study

By **BORIS DMITRIEF**, Construction Engineer, Consolidated Edison Co. of New York, Inc.

AVAILABLE FORECASTS of new air conditioning installations in the immediate postwar years indicate that greatest activity will take place in commercial and industrial fields, and that a good percentage of the new tonnage will be in capacities large enough to economically justify the use of purchased steam as the source of energy for refrigeration.

Equipment Available for Comfort Air Conditioning With Steam

Steam has been successfully used in many types of refrigeration equipment. World War II interfered with new developments to some extent, but there are indications that research has been resumed and that new equipment will appear on the market in the near future. A review of the entire present situation and potentialities was presented by the author before the 1947 annual meeting of the National District Heating Association, (NDHA) from which the following data are taken.

Absorption Machines:—The oldest refrigerating machine used steam in the ammonia-water absorption cycle. Few comfort air conditioning installations utilized it, because of the bulk and complexity of equipment available at the time and the difficulties then encountered in the handling of ammonia. However, the idea of using low-grade, low-cost-energy steam for air conditioning has not been abandoned and is a logical one.

Before the war, the Williams Air-O-Matic Co. (now Eureka Williams Corp.) developed and marketed a line of absorption machines in 7, 15 and 32 ton capacities. These used methylene chloride as refrigerant and dimethyl ether or tetraethylene glycol as solvent. It is reported that over 2000 tons capacity of these units have been installed and are in successful operation. Steam consumption is about 27 lb per ton hour, better than could be realized with any other steam utilizing equipment in this capacity range.

The Servel All-Year Air Conditioning units are of the absorption type, using steam at atmospheric pressure. This steam is generally produced by gas-fired generators incorporated in the unit, but a 10-ton installation now under way in New York City will use steam supplied by the New York Steam Corp. Water is used as the refrigerant and lithium bromide as the solvent. Since water is thermodynamically a better refrigerant than methylene chloride, efficiency is improved. Steam usage is in the order of 20-lb per ton hour.

There is no reason why larger capacity units using the same refrigerant and solvent and suited to any steam conditions cannot be built. Undoubtedly there will be absorption machines developed along these lines, and probably new refrigerant-solvent combinations will be found.

The absorption machine, using lower grade energy and hence less efficient thermodynamically, discharges more heat to the condenser than must be handled in the compression vapor cycle. The heat to be disposed of depends on the steam requirements which, for the absorption unit, will be from two to three times that of the compression machine, depending on efficiency.

Steam Jet Machines:—The paper of M. A. Nelson appearing in the 1936 Proceedings of the NDHA, and articles contained in the 1935, 1936 and 1937 Proceedings, as well as the paper by A. R. Mumford and A. A. Markson entitled, "Application and Economy of Steam Jet Refrigeration to Air Conditioning," ASHVE 44th Annual Meeting, January 1938, exhaustively treat the subject of steam jet and its applications.

Its economic position in comfort air conditioning has not changed since those writings. That steam jet has not been used more extensively is probably due to lack of aggressive promotion by manufacturers and the fact that equipment was placed on the market before it was fully developed, particularly the controls. Introduction of capacity control, effected by throttling the steam to maintain constant differential pressure between flash tank and compressor, resulted in reducing seasonal consumption of some installations by as much as 35 per cent.

Steam jet can be utilized economically under the following conditions: 1—Large capacity—200 tons and over; 2—Steam available at 100 psi and over; 3—Low cost of water, or space available for cooling tower; 4—High sensible heat load factor. The steam jet unit, with capacity control, can take full advantage of

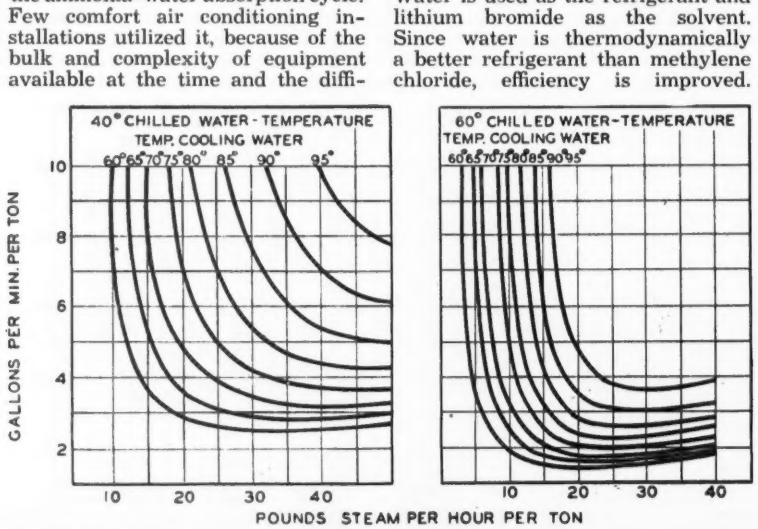
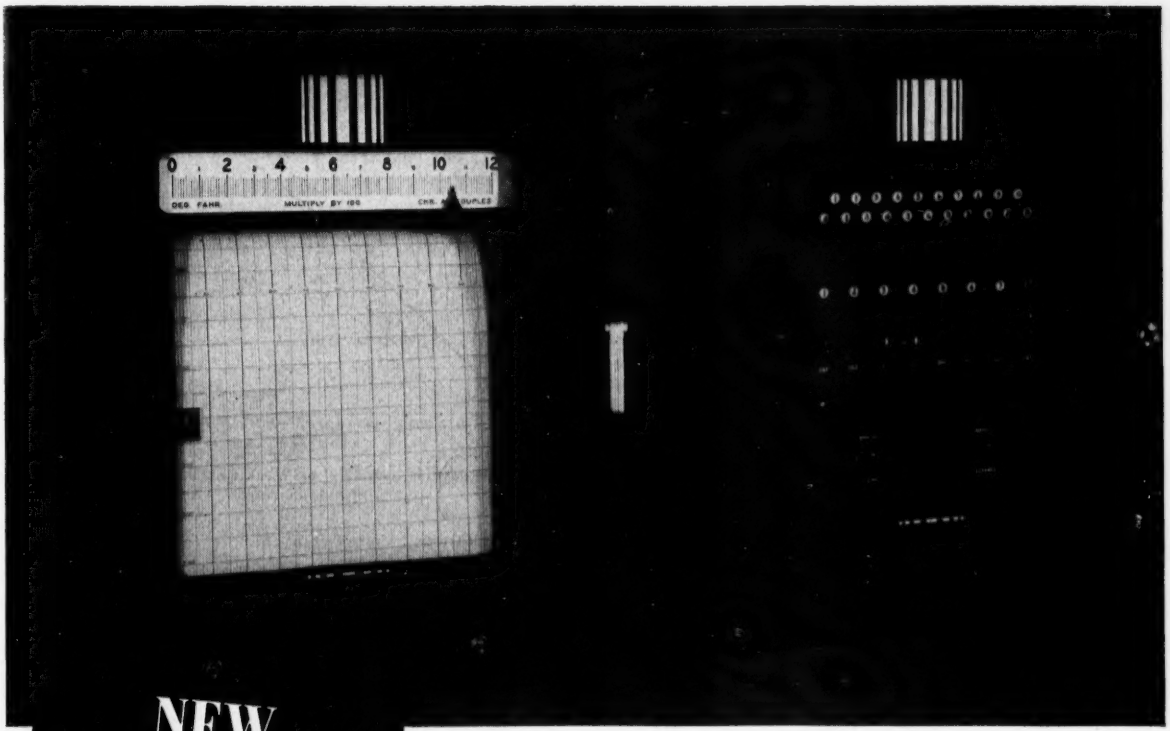


Fig. 1. Typical steam jet performance under varying conditions of chilled water and cooling water. A—For 40 F chilled water temperature. B—For 60 F chilled water temperature. (Courtesy D. H. Jackson, Kroll Reynolds Co., Inc.)



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Remarkably fast, this new Speedomax equipment offers a definite advance in protection for large boilers. With it, the shift operator can "tour" the temperatures of 160 tubes in a little less than eleven minutes. He can stand and watch the readings as they are automatically indicated; or Speedomax will record them for later examination and for the shift log.

In either case, readings are supplied in such rapid rotation that it is generally possible to determine the exact point at which any high or low temperature first develops, even though the condition may later spread to other points. This speed thus helps both to detect and to isolate trouble.

The installation procedure is familiar to most power engineers. The power company's staff simply makes up thermocouples and attaches them to the tubes which they decide will give the most useful temperature readings. Conventional-type couples, at points outside the gas passages, are of course usually included in the installation. Couples are connected to the Speedomax equipment in 8 banks of 20 each, and appropriate alarms are included.

Records When Desired

The Speedomax automatically measures these temperatures at a rate of one every 4 seconds. Signal lights wink on for each couple, and as long as temperature remains correct the instrument merely indicates . . . does not record. It can be made to record at any time, however, by merely throwing a switch. Or if any temperature reaches its predetermined limit, an alarm sounds and the Speedomax automatically records until switched off. Also, any bank or banks of couples can be switched out at any time, thus concentrating on areas of special interest.

For further information about these equipments, please write Leeds & Northrup Co., 4973 Stenton Ave., Phila. 44, Pa.

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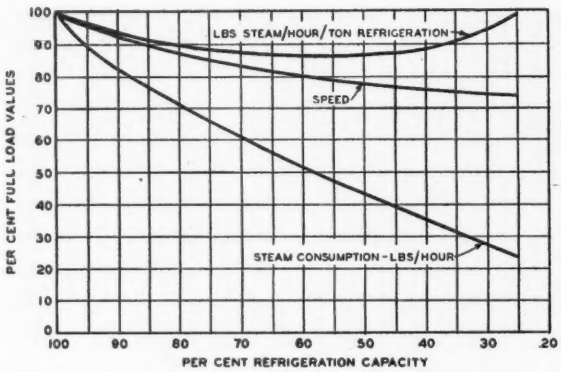

Fig. 2. Steam consumption and speed characteristic curves for variable-speed turbine drive for centrifugal compressors. (Courtesy Worthington Pump and Machinery Corp.)

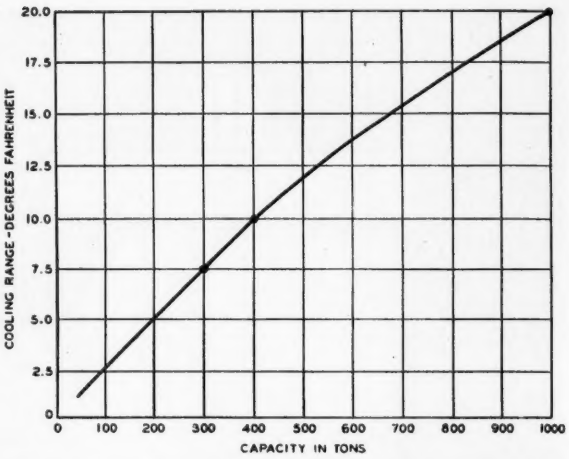

Fig. 3. Increase in capacity of given cooling tower as cooling range increases

lower water temperature from the cooling tower, which results in more efficient partial load operation. This is of utmost importance in most comfort air conditioning installations because of the comparatively low load factor of the refrigeration plant.

We have records indicating that the average seasonal steam usage per ton hour of a well-controlled steam jet unit is comparable to the performance of an efficient steam-turbine-driven centrifugal compressor, both operating on the same initial steam conditions.

The curves of Fig. 1 represent typical steam jet performance under varying temperature conditions of chilled water and cooling water, showing the effects of these variables on the steam usage per ton hour and gallons of cooling water circulated per minute per ton.

A few steam jet units are being installed today. Although it may not be aggressively promoted by manufacturers, do not overlook the possibilities of this type of refrigeration where conditions for its application are favorable.

Steam Mechanical Drive for Compressors

Steam Engines:—Steam engines have been used to drive reciprocating refrigeration compressors. Their use can still be justified economically in large plants where there is a considerable demand for the low pressure exhaust from the engine.

In smaller capacities, the modern uniflow engine operating condensing will have a lower water rate than the equivalent in turbine drive.

The field for the steam engine in air conditioning is limited, principally because of its higher cost as compared with that of the standardized, mass-produced, electric-motor-driven reciprocating compressor.

Steam Turbines:—The present-day trend in large air conditioning installations (250 tons and over) is toward the centrifugal compressor. It has: 1—Reliability (not uncommon to have entire plant capacity in a single unit); 2—Compactness; 3—Economy of operation (efficient use of low cost energy); 4—Low maintenance cost.

Three nationally-known manufacturers, Carrier Corp., Worthington Pump and Machinery Corp., and York Corp., are marketing centrifugal compressors in capacities from 100 to 2600 tons. The descriptive literature of all three stresses that steam turbine is the ideal drive for centrifugal compressors. The reasons are:

1. Elimination of step-up gears. Efficient turbine speeds match the speed requirements of centrifugal compressors on direct drive.

2. Simplicity, flexibility and efficiency of capacity control.

Figure 2 indicates the efficiency possible with capacity control over wide ranges of refrigeration output. These curves assume constant quantity and temperature of condenser water. In actual operation, even better economy is realized at partial loads because of higher condenser vacuum resulting from lower temperature water from the cooling tower.

In its ability to utilize steam at any conditions, the turbine is highly adaptable. Whether initial pressure is in the order of 2000 psi at 1000 F, or 125 psi dry saturated or below

(Continued on page 120)

Table I. Some possible selections and performances of steam turbines to meet an identical load condition

	Type	Required B H P	Required R P M	Initial Condition of Steam	Back Pressure	Water Rate
Turbine No. 1	Single Stage	500	4500	125 psi, Dry Sat.	5 psi	38 lb/hphr
Turbine No. 2	5 Stage	500	4500	125 psi, Dry Sat.	5 psi	29 lb/hphr
Turbine No. 3	5 Stage	500	4500	2 psi, Dry Sat.	26" Vac.	28.2 lb/hphr
Turbine No. 4	5 Stage	500	4500	125 psi, Dry Sat.	26" Vac.	15.6 lb/hphr
Turbine No. 5	9 Stage	500	4500	125 psi, Dry Sat.	26" Vac.	14.3 lb/hphr

Table II. Heat release and cooling tower requirements of different types of air conditioning installations

Type	Heat Release to Cooling Tower Btu per Minute per Ton of Refrigeration	Circulating Water to Cooling Tower GPM per Ton of Refrigeration	Ratio of Floor Space Required for Cooling Tower	Ratio of Cooling Tower Costs
Steam Mechanical Driven Compressor, Atmospheric Exhaust or Back Pressure Operation	235 to 250	3	1	1
Steam Turbine Driven Compressor, Atmospheric Exhaust or Back Pressure Operation	235 to 250	3	1	1
Steam Turbine Driven Compressor, Condensing 27" Vacuum	450 to 500	4 to 5	1.25 to 1.40	1.25 to 1.40
Steam Jet	650 to 750	5 to 7	1.40 to 1.50	1.40 to 1.50
Absorption	500 to 600	4 to 5	1.25 to 1.40	1.25 to 1.40

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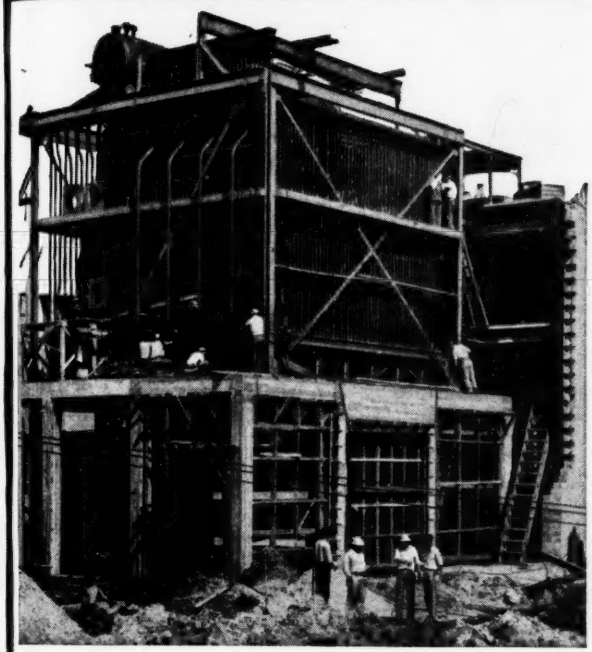

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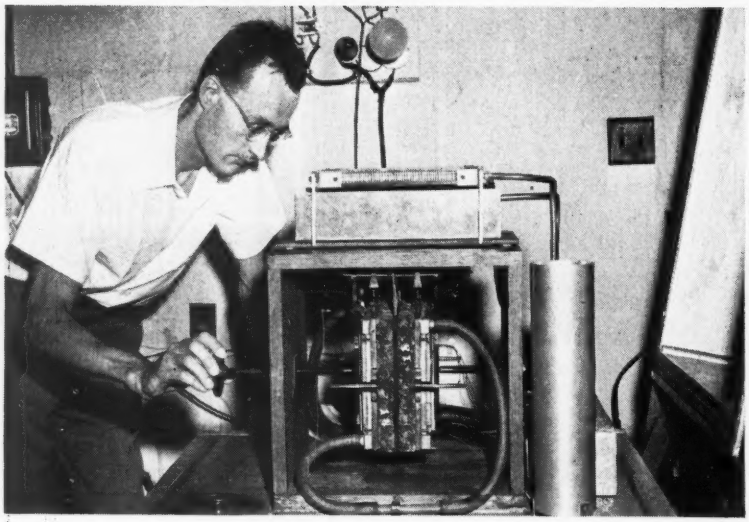

Fig. 3. Apparatus developed at the National Bureau of Standards for determination of the heat conductivity of thermal insulating material. This assembly is now being used at the Bureau in a cooperative program for standardization of the test equipment and methods of other laboratories

ENGINEERED SPECIFICATIONS

(Continued from page 69)

cifications. Prior to 1921 each agency of the Government had its own specifications for all materials it purchased, the requirements often being in conflict with each other and seldom in conformity with commercial practice. To avoid duplication of effort in the procurement of material and to insure better utilization of the national resources and industries, the Federal Specifications Board was established and given the duty of not only compiling and adopting standard specifications but also of bringing them into harmony with the best commercial practice wherever conditions permit. The Board is made up of qualified representatives from the various branches of the Government, with the Director of the National Bureau of Standards as *ex officio* chairman.

Each Federal Specification, of which there are now more than 1900, is formulated by one of nearly 80 Federal Specifications Technical Committees consisting of official representatives of every department and establishment interested in the commodity covered by the specification. Members of the staff of the National Bureau of Standards act as chairmen of between one-third and one-half of these committees. Full consideration is also given to such advice as is obtained from commercial and industrial concerns. The specification thus prepared by the technical committee is submitted to all Government agencies and to interested engineering and technical societies for comment and criticism. All criticisms received are given consideration in placing the specification in final form for use in Government purchasing. Federal Specifications are continually being revised to keep them abreast of the best current manufacturing practice and the needs of the Government.

In addition to Federal Specifications adopted by the Federal Specifications Board, a number of Government agencies formulate and maintain specifications for commodities in which they have a special interest. These include specifications for articles purchased almost exclusively by one or two agencies —such as the Joint Army-Navy Specifications, Army Specifications, Navy Specifications, Air Force Specifications, and Veterans Administration Specifications — and the standards for foods, drugs, and agricultural products established by the Food and Drug Administration and the Department of Agriculture.

Realizing the need for specifications based on research and testing, industrial and engineering groups have also been active in the formulation of purchasing standards. Some of the technical societies conducting or associated with standardization activities are the American Standards Association, the American Society for Testing Materials, the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the National Aircraft Standards Committee. Many of the trade associations and similar industrial groups are deeply interested in simplification as well as standardization.

An important phase of the work of the National Bureau of Standards has consisted in cooperation with the Federal Specifications Board and other standardizing agencies in the development and improvement of specifications and in the testing of Government purchases for conformity with specification requirements. Considerable experimental investigation is carried on at the Bureau in the development of test methods, which are so often indispensable before a specification can be framed or applied. The Bureau's extensive facilities have been utilized in the design of many accelerated tests, such as weathering tests of paints and aging tests for synthetic rubbers. This type of work has provided an excellent opportunity to observe the value of purchasing by specifications.

With the object of bringing about the widespread use of specifications for purchasing, and in order to provide a background for the development of better specifications, the Bureau undertook the compilation of a classified list of specifications which had been formulated not only by public purchasing agencies but also by governmental organizations having national recognition. The result was a guide for both specification writers and buyers of commodities—the National Directory of Commodity Specifications.

In compiling this material, a strenuous effort was made to obtain current information concerning useful standards and specifications from all national organizations that represent industry, or some branch of industry, and that are known to be interested in the formulation of commodity specifications. Consequently, more than 500 such organizations were contacted, including trade associations, technical societies, and the various purchasing agencies of the Federal Government.

Each standard, specification, simplification, code, safety rule, and similar document for general use was examined in order to determine its particular place in the general system of arrangement. Every effort was made to summarize, classify, and index the material in such a way that it would give the user complete and valuable information.

The 1945 revision of the Directory[1], consisting of 1311 pages, was rapidly and widely distributed, but under post-war conditions additional information on new commodities was an obvious necessity. However, instead of issuing an entirely new volume, the National Bureau of Standards has placed all of the new information in a 322-page Supplement[1].

The two volumes provide a complete listing by name, designating number, and issuing or sponsoring organization of all the standards,

(Continued on page 122)

[1] The National Directory of Commodity Specifications (NBS Miscellaneous Publication M178), and its Supplement are available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. The 1945 Directory costs $4.00 a copy; the 1947 Supplement, $2.25. Questions concerning the Directory should be addressed to the Commodity Standards Division, National Bureau of Standards, Washington 25, D. C.

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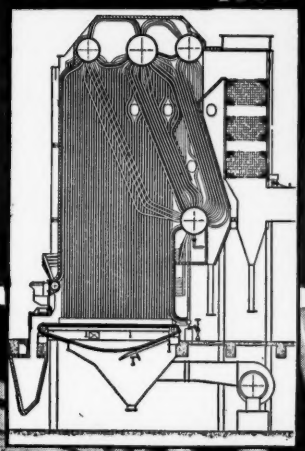
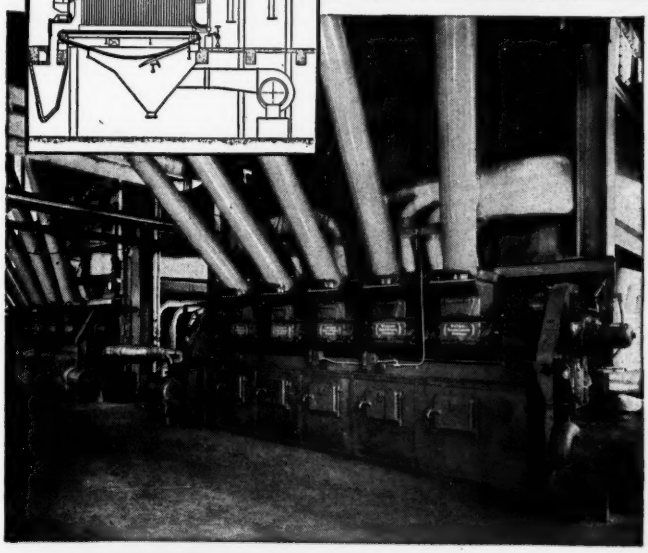


150,000 pound units with Detroit RotoGrate Stokers—Consolidated Paper Company, South Side Plant, Monroe, Michigan.



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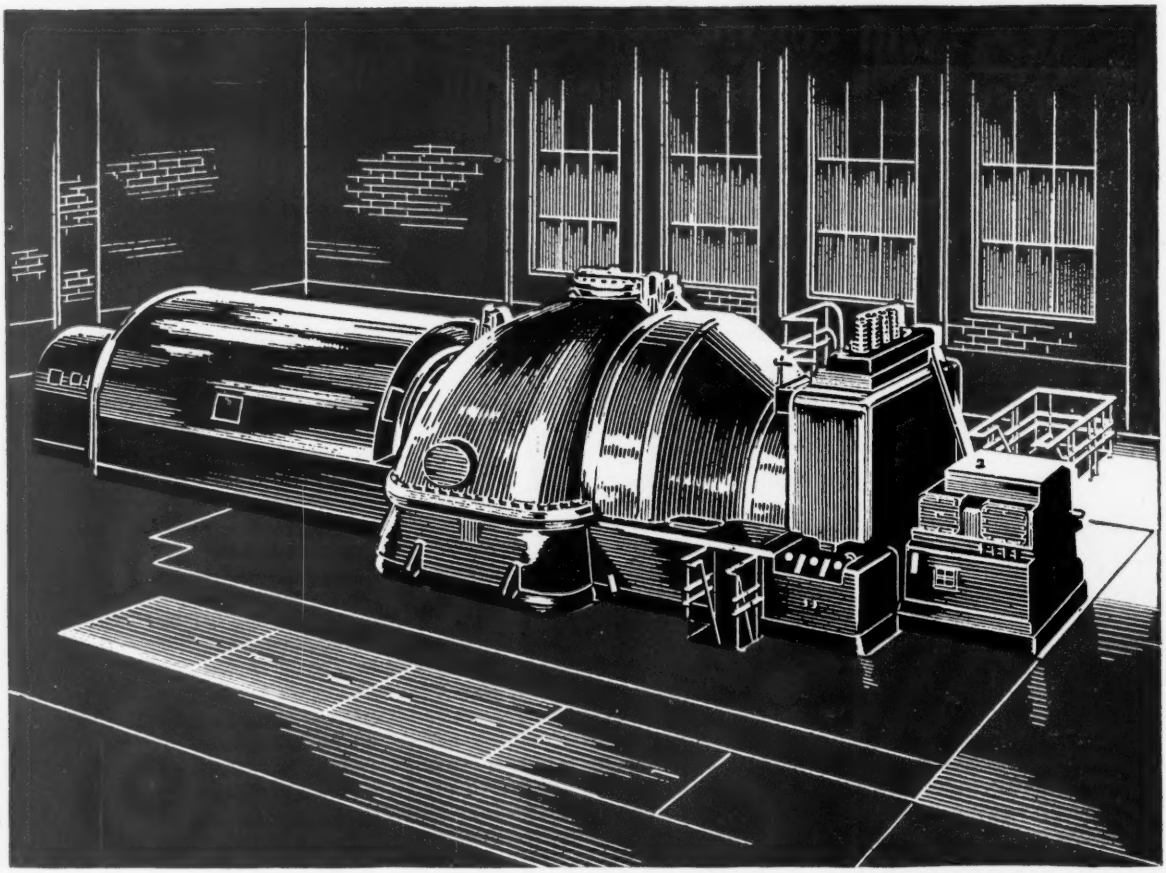

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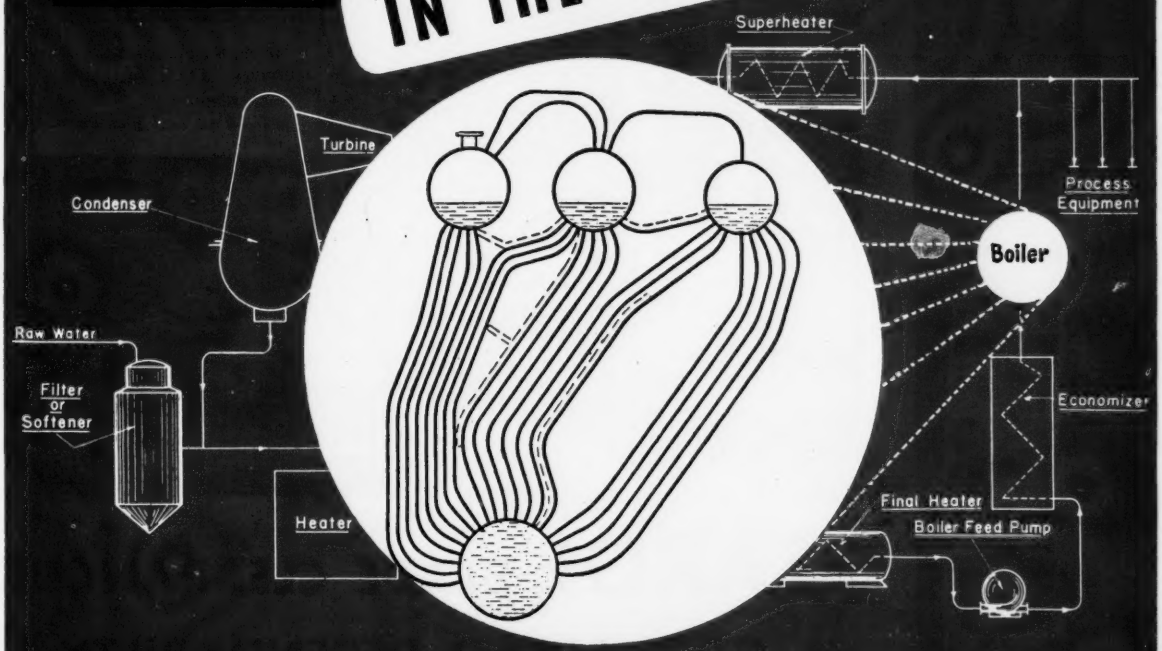

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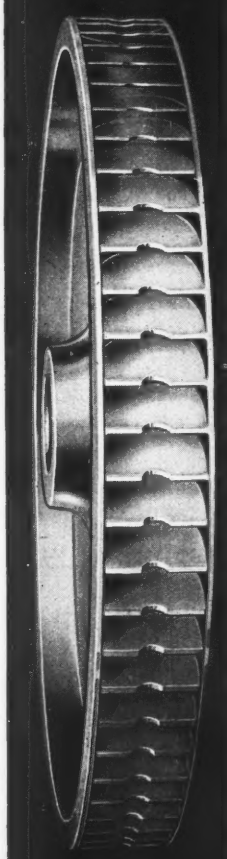

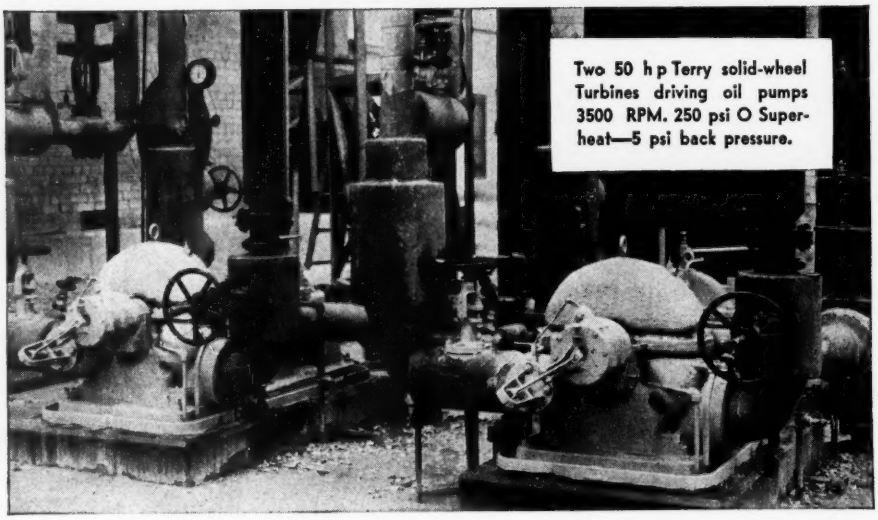

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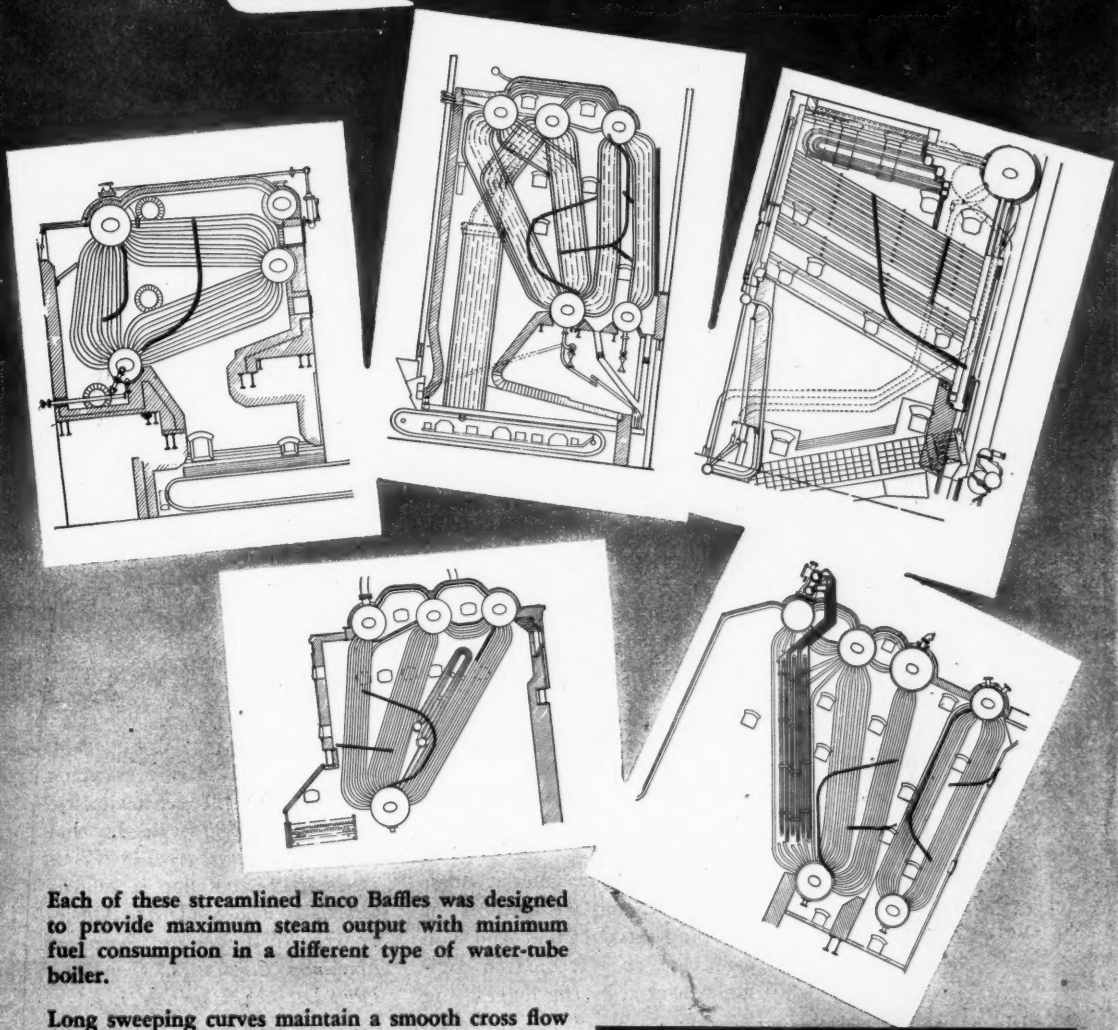
IN EVERY TYPE OF BOILER



Each of these streamlined Enco Baffles was designed to provide maximum steam output with minimum fuel consumption in a different type of water-tube boiler.

Long sweeping curves maintain a smooth cross flow of gases across every square foot of heating surface. Eddy currents, bottlenecks and dead gas pockets are eliminated—draft losses are cut to a minimum. Soot blowers work more effectively, less steam and less time are needed for cleaning.

Enco Streamline Baffles are individually designed and engineered to the exact requirements of your boiler. Experienced Enco-trained crews take charge of the installation.

The 18-page Enco Bulletin, BW44, shows how engineers throughout industry have gotten higher boiler efficiency and increased steam production through the use of Enco Streamline Baffles. Why not write for your FREE copy today?

The Engineer Company Produces:

ENCO OIL BURNERS

ENCO FUEL OIL PUMPING AND HEATING UNITS

ENCO AUTOMATIC OIL-ELECTRIC IGNITION SYSTEM

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THE ENGINEER COMPANY

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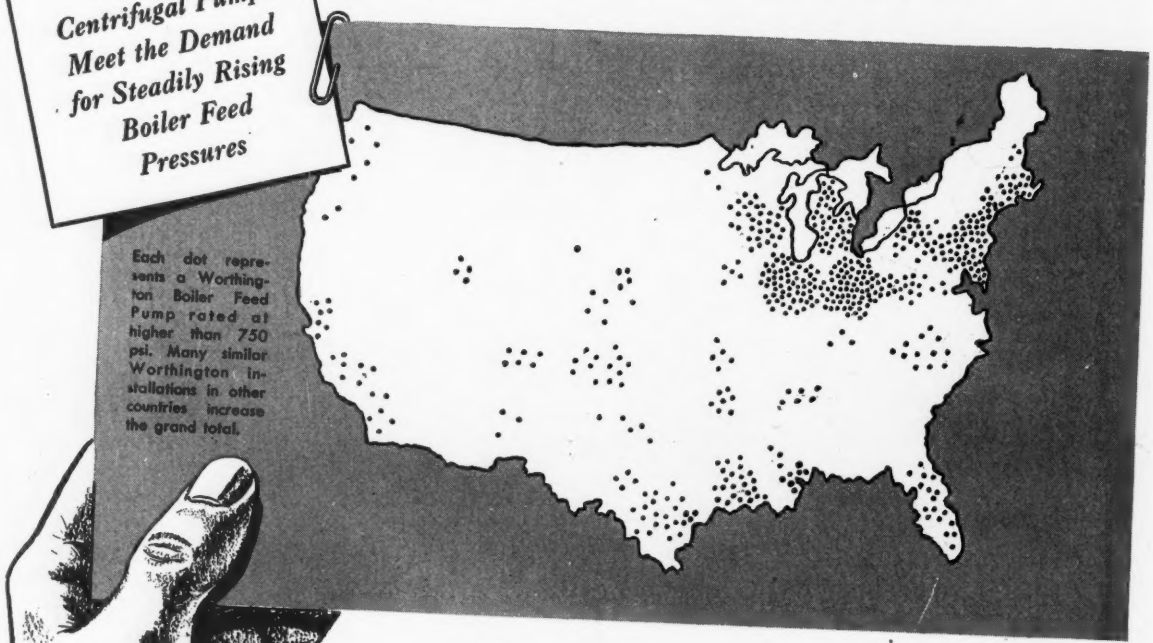
"High-Spots" ON THE HIGH-PRESSURE MAP

Nearly one thousand Worthington High Pressure Centrifugal Pumps, now in boiler feed service, are a testimonial to Worthington's continuous leadership in pump design and manufacture. A long list of pace-setting Worthington design-features have helped to advance feed pressures up to 2400 psi. For example, the Elastic Seal Ring, for tight interstage joints in axially split casings, and the Metal-to-Metal Ring Type Joint in solid-case pumps.

Worthington Centrifugal Pumps Meet the Demand for Steadily Rising Boiler Feed Pressures


Each dot represents a Worthington Boiler Feed Pump rated at higher than 750 psi. Many similar Worthington installations in other countries increase the grand total.

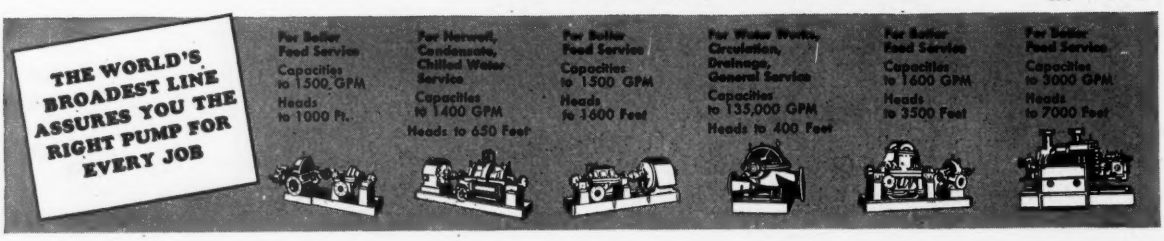
Get the RIGHT Pump for the Job

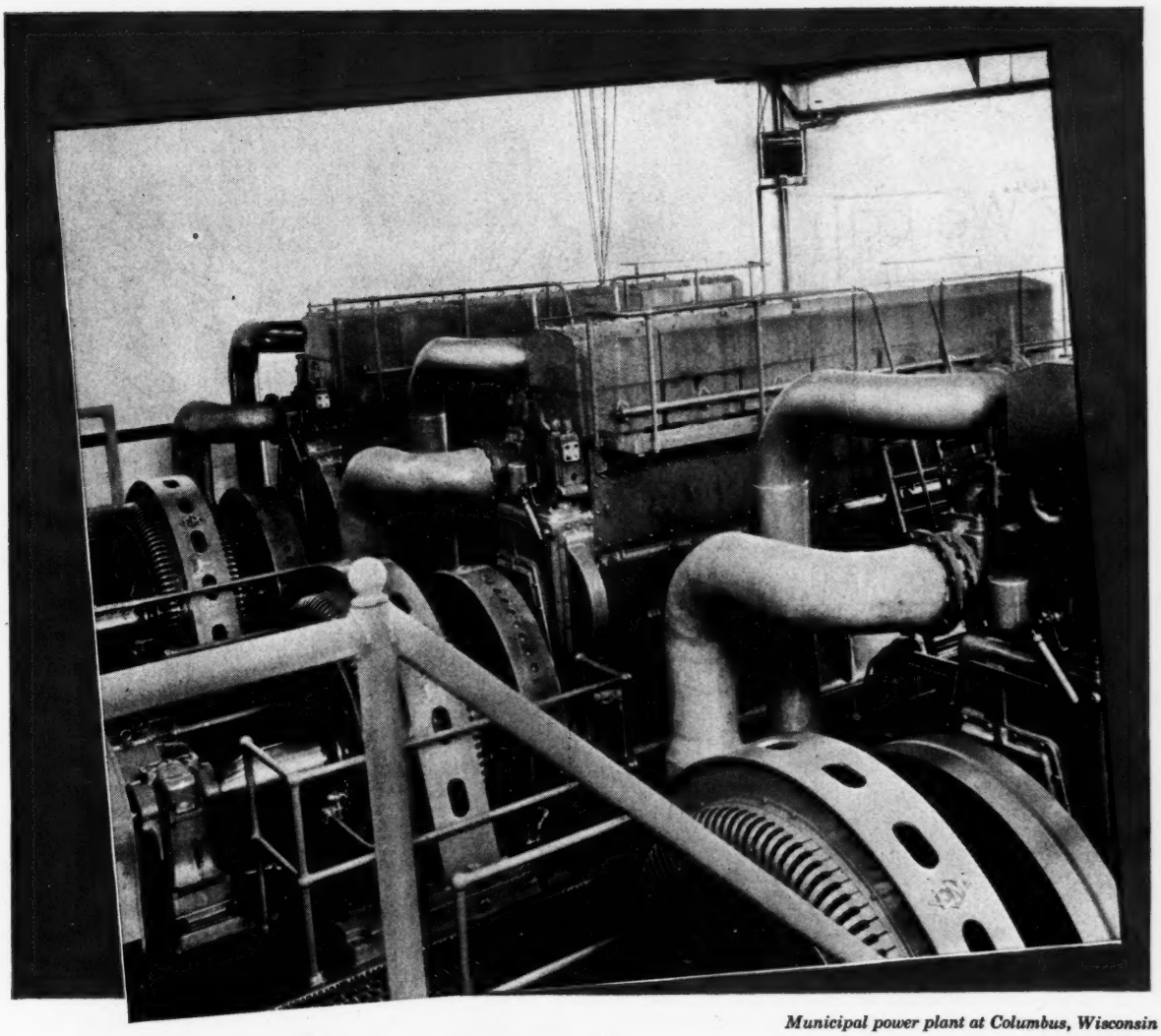
Worthington builds Standard Centrifugal Pumps in all sizes, pressures and capacities. This most complete line offers you the widest choice . . . your one best bet for pumping-satisfaction. And you can count on Worthington engineers, backed by the longest and broadest experience in the field, for expert aid in any pumping problem. For the dependability, economy and long service-life that prove *there's more worth in Worthington*, come to Pump Headquarters. Call our nearest District Office, or write to *Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, N. J.*

WORTHINGTON

CS-1

THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB


For Boiler Feed Service
Capacities to 1500 GPM
Heads to 1000 Ft.
For Harvard, Condensate, Chilled Water Service
Capacities to 1400 GPM
Heads to 650 Feet
For Boiler Feed Service
Capacities to 1500 GPM
Heads to 1600 Feet
For Water Works, Circulation, Drainage, General Service
Capacities to 135,000 GPM
Heads to 400 Feet
For Boiler Feed Service
Capacities to 1600 GPM
Heads to 3500 Feet
For Boiler Feed Service
Capacities to 3000 GPM
Heads to 7000 Feet



Municipal power plant at Columbus, Wisconsin

Case of the smart City Fathers

THE city fathers at Columbus, Wisconsin, have reason for pride in their municipal power plant, with its modern Worthington diesels and streamlined piping. Exhaust cooling and lube lines were put together with Tube-Turn welding fittings. They permitted high-speed installation and assure top piping efficiency with low upkeep.

Tube-Turn welding fittings fit flush with the pipe. Insulation is simplified. Smooth changes in flow direction reduce pressure loss and erosion. The welded connections are strong as the pipe, permanently leakproof, safe. No shutdowns.

Tube-Turn welding fittings carry the No. 1 trade name in the field. They are dependable for strength, dimensional accuracy, and adherence to standards. They come in a wide range of types and sizes, metals and alloys. Your nearby Tube Turns distributor carries a large stock. For good service in good connections, specify "Tube-Turn."

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TUBE-TURN
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WELDING FITTINGS AND FLANGES

Write for folder of quick reference tables, "Dimensional Data and Weights of Tube-Turn Welding Fittings."

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coal

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If this is what you need"

QUALITY

Highest quality coal with guaranteed uniformity through careful inspection. Correct and proper sizing helps meet your specific needs.

DEPENDABILITY

Twenty-one years of coal experience assures you that you can rely on receiving exactly what you order —not a substitute.

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When you order you can expect the shipment to be scheduled properly and made flexible to suit your specifications. Sales and Service offices in the principal cities bring coordination between your order and our shipment.

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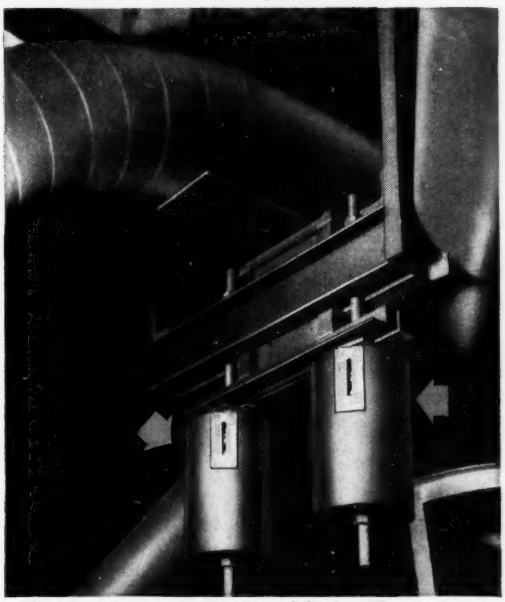
TIDEWATER

Flexible support for pipe that S-T-R-E-T-C-H-E-S

with GRINNELL PRE-ENGINEERED SPRING HANGERS

Selecting hangers for piping subject to thermal movement is completely simplified. Grinnell Pre-Engineered Spring Hangers are available in stock sizes for any load requirement.

Simply compute the load and order the proper size Grinnell Pre-Engineered Spring Hanger as indicated in the Capacity Table appearing in descriptive catalog. 14 sizes with load range from 84 lbs. to 4,700 lbs.



Showing reverse application of Spring Hangers on a flexible piping support.

Flexible suspension of piping in one of world's largest catalytic cracking plants.

LOOK AT THESE FEATURES . . .

- **The maximum variation in supporting force per ½" of deflection is 10½% of rated capacity—in all sizes.**
- **Guides prevent contact of coils with casing wall or hanger rod and assure continuous alignment and concentric loading of spring.**
- **Compact—minimum headroom made possible by precompression*.**
- **Precompression* assures operation of spring within its proper working range where variation in supporting force is at a minimum.**
- **All-steel welded construction meets pressure piping code.**
- **14 sizes available from stock—load range from 84 lbs. to 4700 lbs.**
- **Easy selection of proper sizes from simple capacity table.**
- **Installation is simplified by integral load scale and travel indicators.**
- **Unique swivel coupling provides adjustment and eliminates turnbuckle.**

Precompression is a patented feature

Write for descriptive folder on Pre-Engineered Spring Hangers Fig. 268.

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GRINNELL

WHENEVER PIPING IS INVOLVED

71-1-1

BEHIND THE IRON CURTAIN

what goes on—beyond this barrier?

Not always what theory teaches us. More than modern instrumentation can tell us. Much, indeed that only off-the-line inspection will reveal—too late, perhaps, for corrective action.

Yet here-and-now facts on the condition of internal boiler surfaces are always yours when APEXIOR NUMBER 1 guards tube and drum steel.

For APEXIOR permanently stabilizes metal beneath a surface which moisture cannot penetrate. Thus isolated from any environment with which it can react to its own detriment, APEXIORized steel loses none of the characteristics of new or newly cleaned metal—can be depended upon for changeless year-in, year-out service.

A further benefit is that APEXIOR's smooth surface attracts fewer and less tenacious deposits so that tubes and drums stay cleaner longer for uniform heat distribution, better circulation and constant high heat transfer efficiency.

These are some of the reasons why for 31 years APEXIOR has played so important a role in the power plants of American Industry—why today engineers in ever-increasing numbers specify it for boilers of all pressures and ratings, operating under all conditions of feedwater control.

For a complete picture of what APEXIOR protective surfacing can mean to your boiler, write us for more facts about

DAMPNEY Maintenance for Metal

THE DAMPNEY COMPANY of AMERICA • Hyde Park, Boston 36, Mass.

COMING EVENTS

AISE—Iron and Steel Exposition and Convention to be held at the Cleveland Public Auditorium, Cleveland, September 28-October 1.

ACS—Fifth National Chemical Exposition of the American Chemical Society to be held at the Chicago Coliseum, Chicago, October 12-16.

ASCE—1948 Fall Meeting of the American Society of Civil Engineers to be held in the Statler Hotel, Boston, October 13-15.

Water Conference—The Ninth Annual Water Conference of the Engineers' Society of Western Pennsylvania will be held in the Hotel Wm. Penn, Pittsburgh, October 18-20.

Safety—36th National Safety Congress and Exposition will be held in Chicago, October 18-22. Meetings to be held in the following hotels Congress, LaSalle, Morrison, Sherman and Stevens. For further information write to George E. Burns, National Safety Council, 20 W. Wacker Drive, Chicago 6, Ill.

Hydraulics—1948 Annual Meeting of the National Conference on Industrial Hydraulics to be held at the Sheraton Hotel, Chicago, October 20-21.

ASM—Annual Convention of the American Society for Metals to be held at the Benjamin Franklin Hotel, Philadelphia, October 23-29.

AIMME—Annual Fall Meeting of the Institute of Metals Division American Institute of Mining and Metallurgical Engineers to be held at the Hotel Adelphia, Philadelphia, October 25-28.

AWS—Annual Convention of the American Welding Society to be held at the Bellevue-Stratford Hotel, Philadelphia, October 25-29.

ASME—The annual meeting of the American Society of Mechanical Engineers to be held at the Hotel Pennsylvania and New Yorker, New York, November 28-December 3.

Power Show—18th National Exposition of Power and Mechanical Engineering will be held in the Grand Central Palace, New York, November 29 to December 4.

SESA—The Annual Meeting of the Society for Experimental Stress Analysis will be held at the Hotel Commodore, New York, December 2-4.

AIEE—Conference on Electric Welding to be held in Detroit, December 6-8.

ALDUS G. HIGGINS

ALDUS C. HIGGINS, 75, died September 10 at his home, 1 John Wing Road, Worcester, Massachusetts.

Mr. Higgins, at time of his death, was chairman of the Norton Co. executive committee. His first Norton employment was as patent counsel, starting July 1, 1900. He had served in many Norton executive positions including that of president, general manager and chairman of the board of directors.

Mr. Higgins was also chairman of the board of Riley Stoker Corp., and a director of Liberty Mutual Insurance Co. of Boston, Worcester County Trust Co., Boston & Maine Railroad, Indian Hill Co., and Norton Co. of Canada, Limited.

He was president and a trustee of Worcester Art Museum, a trustee of the Worcester Memorial Hospital and a life-member of the trustees of Worcester Polytechnic Institute.

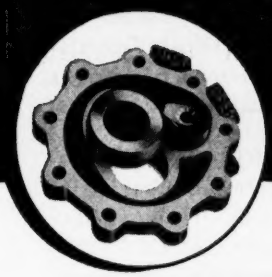
Mr. Higgins was born in Worcester, December 7, 1872, son of Milton Prince Higgins, one of the founders of Norton Co., and Katharine Elizabeth (Chapin) Higgins.

He was educated in Worcester and received a bachelor of science degree from Worcester Polytechnic Institute in 1893 and an honorary doctorate in engineering from W.P.I. in 1931.

From patent counsel with Norton Emery Wheel Co., Mr. Higgins progressed to counsel and resident manager of the abrasive plant in 1901. From 1919 to 1933 he was treasurer and general counsel and in 1933 succeeded the late Charles L. Allen as president, becoming both president and general manager.

He was elected chairman of the board of directors in 1941 and held this position until January 1946, when he became chairman of the executive committee.

STOP WORRYING ABOUT FIRE!



Get EVERLASTING VALVE *protection*

Here are two valves you can *depend on* for protection of your property when fire threatens. Weight-operated with pendulum stop — controlled thermostatically, electrically, or manually — they provide instant action for instant protection.

Available in both opening and closing types, these Everlasting Valves are suited for Dip Tank Discharge, Fuel Oil Shut-off, Foam and other Fire Protection Systems.

For emergency shut-off of inflammable liquids, or to concentrate water or steam in fire mains, specify the *Closing Type* Everlasting Valve (Fig. 4831 BC).

For diversion of water to sprinkler deluge or water curtain systems, or to divert inflammable liquids to a safe point, specify the *Opening Type* Everlasting Valve (Fig. 4721 BC).

Positive in action, these Everlasting Valves provide instant, unfailing protection when released. They will not stick because their materials will not corrode in use. They will not bind because there is no external stuffing box. They will not wedge because the disc action parallels the valve seat. Straight-through design permits a full unimpeded flow.

What's more, no pendulum swing-stop is necessary. At bottom of its swing, the weighted pendulum is disengaged from the valve mechanism . . . there's no possibility of valve fracture due to impact.

For all details on these Everlasting fire protection valves, send for our Bulletin E-52 C — *today!*

Manufactured by

EVERLASTING VALVE COMPANY

49 Fisk Street, Jersey City 5, N. J.

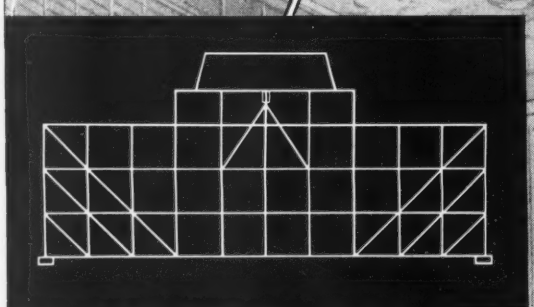
Trade-Mark "EVERLASTING"—REG. U. S. PAT. OFF. EV-330

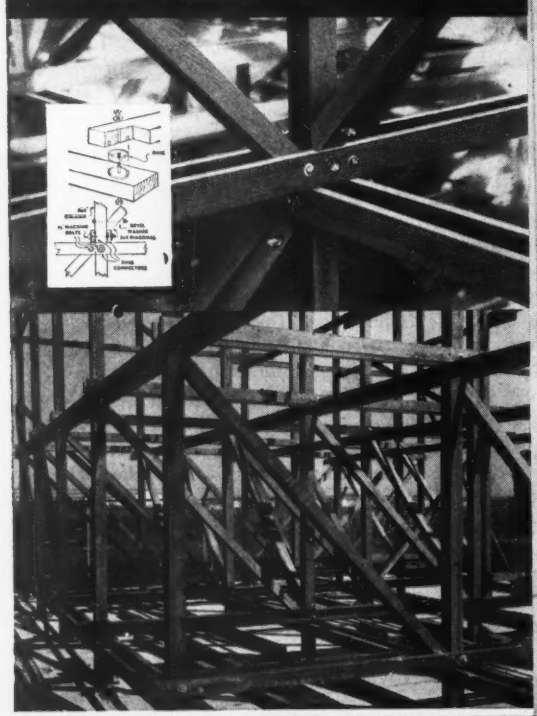
EVERLASTING VALVES *GIVE "EVERLASTING" SERVICE*

HURRICANE
TORNADO
EARTHQUAKE

Whatever the Elements Present

Double-Flow
COOLING TOWERS
Are Built To Take It!





Your cooling tower may never have to withstand these elemental furies, but when you install a Marley Double-Flow you have complete assurance that your tower can and will take it. The proof of this is the fact that Double-Flows have been subjected to Atlantic and Gulf hurricanes, mid-western tornadoes, Pacific earthquakes. When the force of wind was spent and seismic shock stilled, Double-Flow towers stood undamaged beside the debris of less sturdily built units.

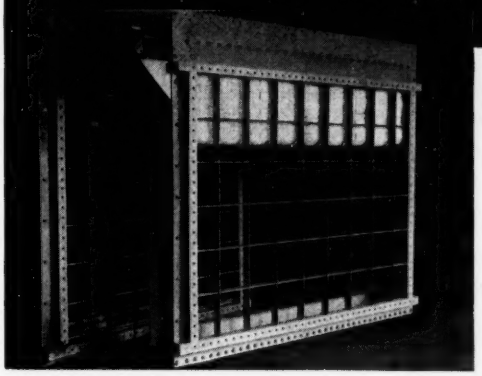
Designed for 30-pound wind load, Double-Flow towers have safely resisted velocities greatly in excess of that figure. Why? The answer is the built-in SAFETY FACTOR of Marley design. In structural strength, as in functional ability, Marley engineers disregard "allowable minimums" and produce truly safe and properly balanced designs.

Ask your nearest Marley engineering service representative to give you the facts and figures that will let you determine the extent to which Double-Flow towers are designed for safety.

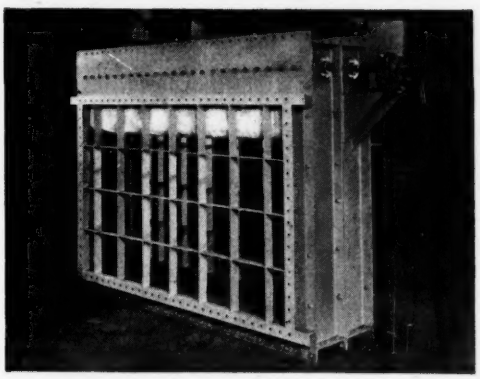
MARLEY COOLING TOWERS

THE MARLEY COMPANY, INC. • KANSAS CITY 15, KANSAS

for single direction flow . . . or reverse flow control . . .



SVH Type Heacon Damper regulates flow in one direction.



DVHR Type Heacon Damper regulates flow in either direction. Note double grill against which two curtains ride.

HEACON DAMPERS handle both!

Illustrated on this page are two types of the most widely used dampers. The SVH (single curtain—Vertical damper—Horizontal duct) and the DVHR (double curtain—Vertical damper—Horizontal duct—Reversing flow).

These types answer most damper requirements and, although tailor made to the application, they are considered the basic Heacon Damper design.

The Heacon Damper is unique in design. Sealing off and control of gases is accomplished by means of a flexible curtain of steel, asbestos, rubber or canvas, depending on application. This curtain operates vertically and is held against the grille and seals by the flow. As the curtain is rolled up, opening the damper, it peels from the grill. This action relieves the operating spindle of all torque, and permits the use of a constant, moderate power for operation.

Flow curve of the Heacon Damper may be modified to almost a straight line by means of V-porting. This is particularly important when the damper is to be used as a control mechanism. Some advantages of the Heacon Damper are: Better Regulation, Increased Capacity, Appreciable Reduction in Maintenance, Lower Banking Losses and Constant Power Requirements for Operation.

Let our engineers assist in solving your damper problems. A call or letter will bring you our Heacon Bulletin No. 10.

HEACON

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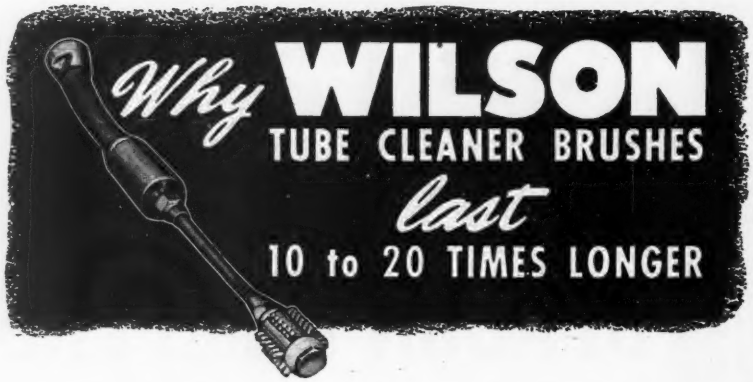
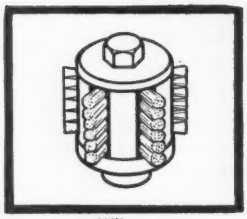
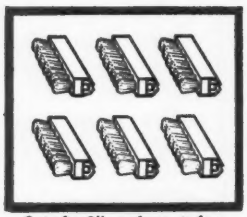



Wilson Expanding Brush

Frame or body of expanding brush


Set of refills or faggots for expanding brush

Ten to twenty times as many tubes can be cleaned with a Wilson Expanding Brush than with ordinary sectional brushes before replacement is necessary. When removing the light, powdery deposits or for final polishing of tubes, the savings in time, labor and money derived from this feature alone make the expanding brush an essential part of very tube cleaning equipment.

This longer life results from the expanding action of the brush. Because any brush must be smaller than the I.D. of the deposit it removes, the ordinary sectional brush cleans by vibrating against the inner tube wall with a pounding action which hammers down the brush elements.

In the Wilson Expanding Brush, centrifugal force holds the tufts in constant contact with the deposit — eliminating this destructive pounding. Worn tufts in the Wilson Expanding Brush can be replaced easily and quickly — and at low cost.

A copy of the Wilson Tube Cleaners Check List will help you select the right Wilson equipment to do your tube cleaning jobs faster and more effectively. Write for your copy today.

MODERN TUBE CLEANERS FOR THE PROBLEMS OF TODAY

TW-696

THOMAS C. WILSON Inc.
21-11 44th AVENUE, LONG ISLAND CITY 1, NEW YORK

CONSIDER STEAM FOR AIR CONDITIONING

(Continued from page 104)

atmosphere, whether operation is to be condensing or non-condensing or a combination of both as in the extraction or mixed pressure turbines, equipment can be obtained that will utilize steam efficiently.

Selection of the type of turbine after capacity and rpm are established and physical limitations considered, is nothing more than a problem in economics. The main factors usually taken into account are cost of energy for steam and auxiliaries, yearly interest charge on investment, and amortization of first cost over the anticipated life of the installation. Since the cost of steam is an appreciable part of the total, the water rate of the turbine is an important consideration. Table I includes some of the possible selections of a turbine for the same load. The progressively improving water rate from turbine No. 1 through turbine No. 5 is accompanied by a progressively increasing total first cost for turbine, condenser and cooling tower. (First costs are not tabulated because of obvious difficulty in doing so). The point at which further increase in first cost is no longer warranted by lowered operating cost is a matter for determination.

A secondary effect, insofar as cost is considered, is the smaller cooling tower made possible by the lower water rate of the more efficient turbine. However, where space is limited and structural changes are necessary for the installation, it may be of major importance.

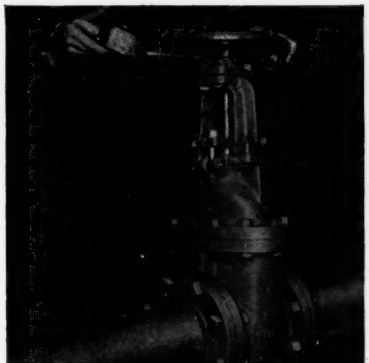
Cooling Towers

Unless an adequate supply of low-cost cooling water is available, a cooling tower must be provided for any of the installations discussed. Only the heat of the refrigeration compressor need be considered when the steam turbine or steam engine is operated non-condensing. The addition of the condenser roughly doubles the load on the cooling tower. *This does not mean, however, that the size or cost of the tower will increase in proportion.* Usual practice is to connect the refrigerating and turbine condensers in series. Temperature of water to the tower is thus increased, which increases the rate of heat transfer from the tower, or in effect increases its cooling capacity.

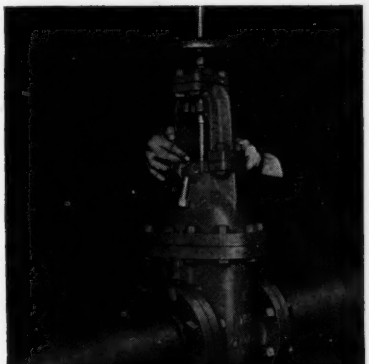
Figure 3 illustrates the increase in capacity of the same tower as the cooling range increases, based on performance guaranteed by one manufacturer for a particular installation.

Table II gives an approximate comparison of the requirements of several types of steam refrigeration with respect to cooling water, size

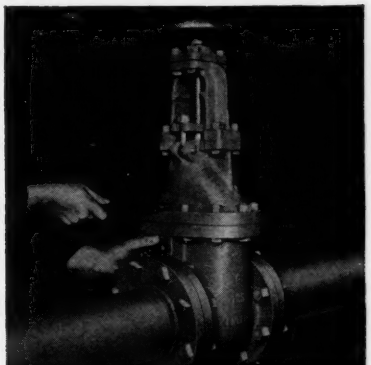
MAINTENANCE IS EASY when you use Kennedy Valves



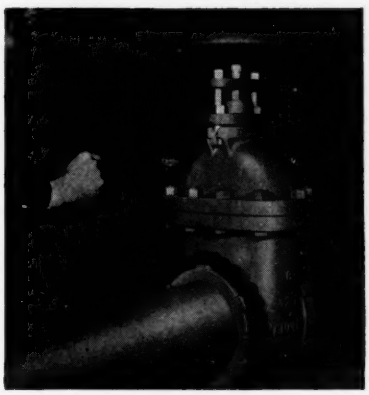
Kennedy Valves are designed for easy maintenance. This Kennedy Iron-Body Wedge Gate Valve, for example, is easy to lubricate. A conveniently-located oil hole is provided in the yoke cap . . . accessible even when the valve is closed.



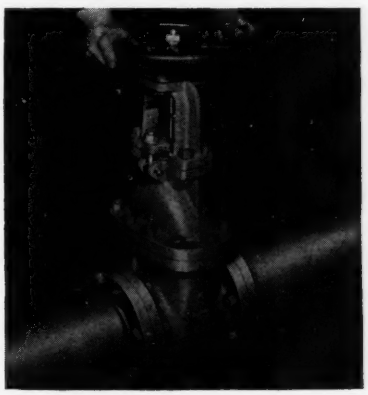
Repacking the gland is easy, too. Gland bolts need only be loosened and swung out, and the packing gland lifted on the stem and rested on shelves inside the yoke, out of the way. It may be packed under pressure when valve is wide open.



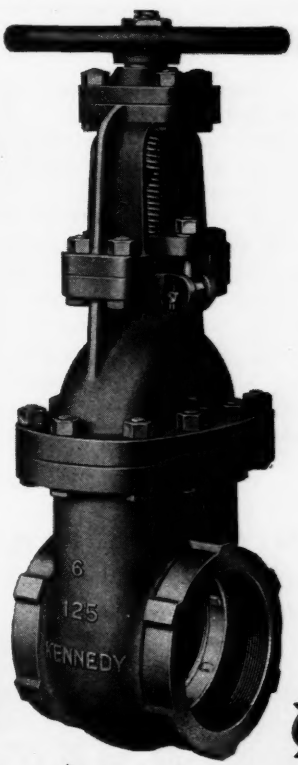
All bolts on body, yoke and flanges are readily accessible, with ample room for swinging the wrench. Nuts are on top of the yoke flange—not underneath. Gland bolts have washer nuts to eliminate the nuisance of loose washers.



On screwed end valves, lugs are provided around the outside of the end connections for convenience in applying a pipe or chain wrench.



Operation of the valve, too, is easy. The large-diameter hand-wheel provides ample leverage for effortless opening and closing of the valve.



The Kennedy Iron-Body Wedge Gate Valve is only one of hundreds of Kennedy Valves, all designed for minimum maintenance, easy operation, and long service life. For details see Kennedy's 240-page Catalog.

THE KENNEDY VALVE MFG. CO., ELMIRA, NEW YORK
Offices and Warehouses in Principal Cities

KV-175

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Niagara Aero Heat Exchangers also give extra value in cooling jacket water for process equipment or engines, hydraulic equipment, electronic sets, controlled atmosphere processes, and many other applications.

Write for Bulletin No. 96-PG

NIAGARA BLOWER COMPANY

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District Engineers in Principal Cities

INDUSTRIAL COOLING HEATING • DRYING

NIAGARA

HUMIDIFYING • AIR ENGINEERING EQUIPMENT

of tower and tower cost. The last is presented as a ratio, since exact figures, even if obtainable, would be of little value.

The selection of a tower must include consideration of: 1—Cost of tower; 2—Cost of installation; 3—Cost of piping; 4—Cost of energy for fans and pumps; 5—Space available. Generally speaking, in installations of large tonnage, the added cost of the tower to accommodate the turbine condenser is insignificant in comparison with the total cost of the complete air conditioning installation, and may well be within the accuracy of the estimate.

A table was included in the paper listing the location, type of installation, tonnage and other information of the comfort air conditioning plants using steam supplied by the New York Steam Corp. Specific operating data on some of these are being compiled for presentation in future issues.

ENGINEERED SPECIFICATIONS

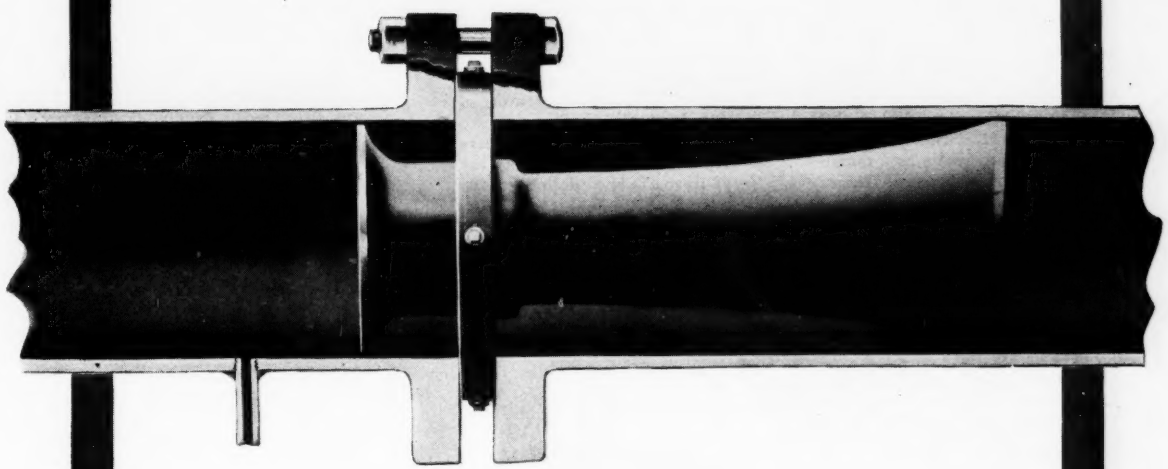
(Continued from page 106)

specifications, and methods of test in general use in this country. Included are the voluntary *Simplified Practice Recommendations* and the voluntary *Commercial Standards* which have been developed by industry under the cooperative procedure of the National Bureau of Standards. Many items are not strictly commodity specifications but closely related information essential to most users. Each specification, of which there are a total of 44,000, is briefly summarized as to technical characteristics, scope, and special applications. An extensive alphabetical index lists individual items under their various trade and technical names in order to facilitate the ready location of any item. A list of addresses of the issuing or sponsoring organizations is also provided, from whom copies of the standards and specifications may be obtained.

The material in the Directory and Supplement is especially coordinated for the use of new manufacturers who need detailed information concerning finished goods or practical data on available materials. It is equally valuable to old, established manufacturers who desire to introduce new products or to use materials with which they are not familiar.

The grouping together of items related to the same subjects or commodities is made possible by a decimal system of classification in the issues of the Directory that have been published to date. In future revisions, a new classification system which is expected to be adopted generally by Government and nongovernmental agencies will be used. In fact, every effort will be made to increase the usefulness of the Directory.

TYPE TG
INSERT VENTURI TUBE



SIMPLEX TG Venturi Tubes meet all the conditions required of an approved primary device. Specifically designed for high pressure conditions, but equally adaptable to low pressures, they offer such advantages as

★ HIGH ACCURACY ★
★ STABLE COEFFICIENT VALUES ★
★ LOW FIRST COST ★
★ MINIMUM OF MAINTENANCE ★
★ LOW PRESSURE LOSS DUE TO PRESENCE IN LINE ★

For full details described in Bulletin No. 450 write to the SIMPLEX VALVE & METER COMPANY, 6783 Upland Street, Philadelphia 42, Pa.

SIMPLEX

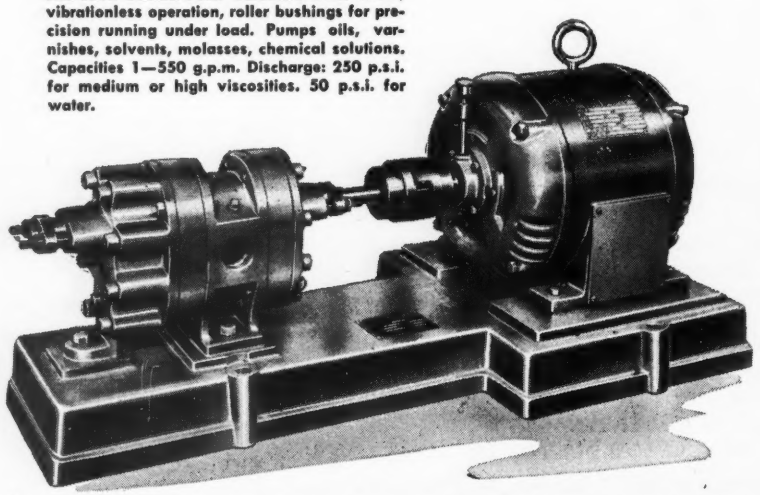
VALVE AND METER COMPANY

If down-time is a headache specify SIER-BATH GEAREX PUMPS

THE design and construction of Sier-Bath Gearex Pumps have been planned to insure continuous service and to avoid shut-downs. Manufacturing pumps of the utmost durability comes naturally to this Company, for Sier-Bath has been famous for many years as a manufacturer of precision gears. Gearex pumps are made under the same high standards that have been inherent in this shop in the making of fine, accurate gears.

Gearex Pumps are long-lived positive displacement units, discharging liquids without pulse or vibration. Double helical pumping rotors and discharge passages of proper area to insure continuous overlapping displacement of liquids are a feature of the Sier-Bath Gearex Pump. Since the rotors are not in contact, there is very little wear. The rotors are keyed to shafts and carefully timed through heat treated steel timing gears, keyed and locked on the ends of the shafts. These are only a few of the fine points of construction in these high quality pumps. Send for booklet.

SIER-BATH GEAREX PUMP Balanced axial thrust, vibrationless operation, roller bushings for precision running under load. Pumps oils, varnishes, solvents, molasses, chemical solutions. Capacities 1—550 g.p.m. Discharge: 250 p.s.i. for medium or high viscosities. 50 p.s.i. for water.



For Higher Pressures and Capacities, Use SIER-BATH SCREW PUMPS

ALSO MAKERS OF SIER-BATH PRECISION GEARS

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INDIA TO BUILD HIGHEST DAM IN THE WORLD

WATER IS PART OF India's enormous natural wealth which, if properly exploited, might put her on the top of power-producing countries of the world. Very little, unfortunately, was done in the past to develop this potential energy. The new National Government of India is working on a dozen or more hydro-electric schemes which will provide approximately four million killowatts of electric energy to numerous industrial plants in India which are being set up or will be set up in the future, to operate pumping machinery for irrigation and drainage, and for domestic use. Some of the projects are, like the TVA, multi-purpose.

In addition to power generation, high-level irrigation and navigation are other objectives. American experience and technical skill are helping in the execution of these projects.

The most spectacular project is the dam across the Kosi river near Barahkshetra in Nepal territory. The dam will rise 750 ft to 850 ft above bedrock and be the highest dam in the world, Boulder Dam being only 730 ft. The power station at the dam will have the installed capacity of 1,800,000 kw, extending electricity to every village and home in most parts of Bihar and Nepal, and leaving ample reserves for large-scale industrial development.

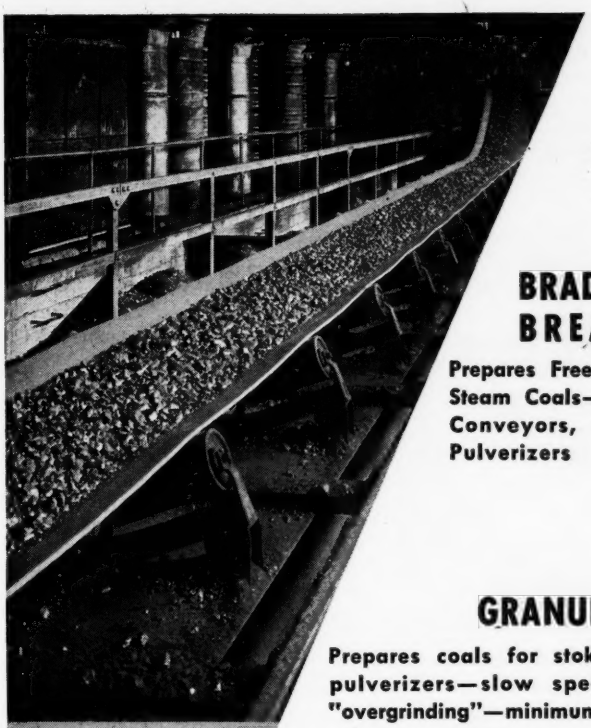
In addition, it will make possible irrigation of one million acres of land in Nepal and two million acres in Bihar, thus providing an annual addition of one million tons to the food production of the area. Another benefit is that the river channel, which has changed its course nine times and has devastated approximately 4000 square miles of land in Nepal and Bihar, will be stabilized and made fit for navigation throughout the year. The construction of the dam is expected to take ten years and cost about $300,000,000. Dr. J. L. Savage, the famous American expert on dam construction, visited the site recently and gave useful advice to Indian engineers engaged on the task.

Another important dam will be built across the Godavari river, near Polavaram, about 20 miles above Rajamundry in Madras province. It is estimated to cost $250. million, and take eight years to complete. The design has been completed by Indian Engineers of the Madras Government in consultation with Dr. Savage, and the International Engineering Company of Denver, Col. American contractors have already been invited to get in touch with the Madras Public Works Department to undertake the construction. It is also anticipated that the major portion of the construction machin-

"PENNSYLVANIA" STEELBUILT

CRUSHERS

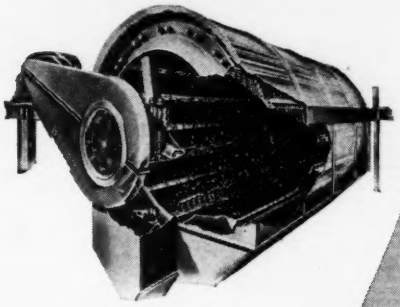
FOR CENTRAL STATIONS AND INDUSTRIAL POWER PLANTS



Typical "Pennsylvania" Bradford Breaker prepared coal, just as it came from the breaker at a Central Station installation. (Unretouched photograph.) Uniform, no oversize, minimum fines.

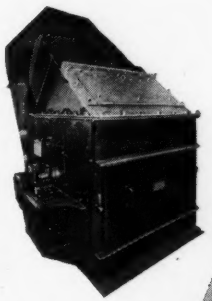
BRADFORD BREAKER

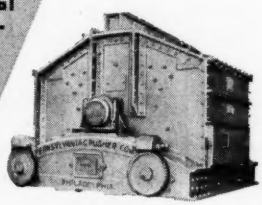
Prepares Free-Flowing Steam Coals—Protects Conveyors, Stokers, Pulverizers



GRANULATOR

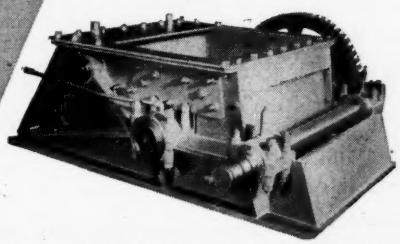
Prepares coals for stokers and pulverizers—slow speed, less "overgrinding"—minimum dusting—low maintenance and power





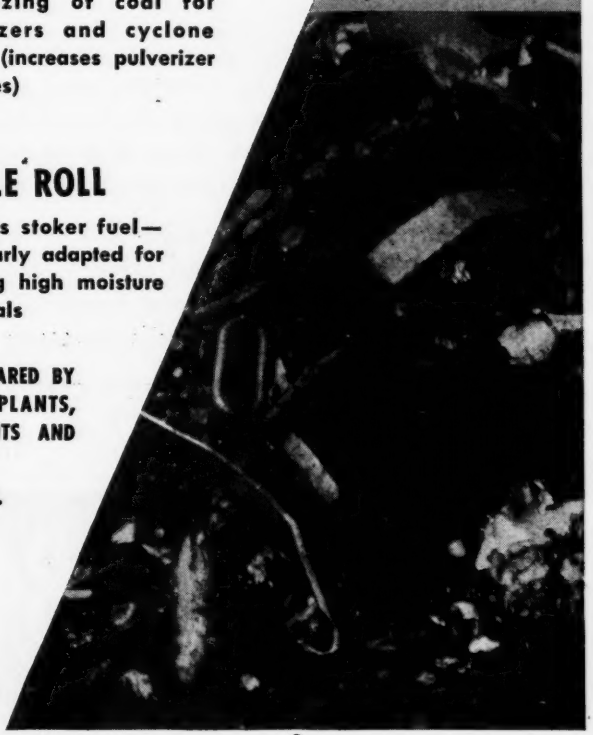
REVERSIBLE HAMMERMILL

Fine sizing of coal for pulverizers and cyclone burners (increases pulverizer capacities)



SINGLE ROLL

Prepares stoker fuel—particularly adapted for handling high moisture strip coals



Typical pile of tramp iron and other refuse removed automatically from coal during preparation by Bradford Breaker.

OVER 300,000,000 TONS OF COAL PER YEAR ARE PREPARED BY "PENNSYLVANIA" CRUSHERS IN MINES, CLEANING PLANTS, BY-PRODUCT COKE PLANTS, INDUSTRIAL POWER PLANTS AND CENTRAL STATIONS.

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PENNSYLVANIA CRUSHER COMPANY

DIVISION OF BATH IRON WORKS CORPORATION

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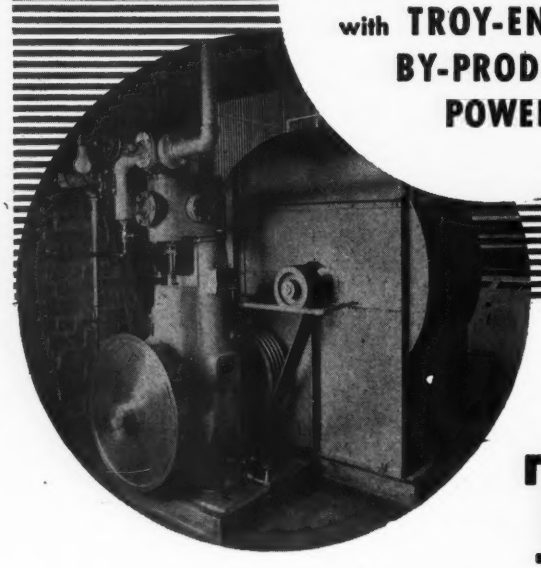
ARE *You* WASTING BOILER HORSEPOWER ?

GET *Maximum* STEAM EFFICIENCY with TROY-ENGBERG BY-PRODUCT POWER



The modern Troy-Engberg Steam Engine is designed to extract the power from the steam you produce before it passes, with little loss in heating value, into your heating or processing cycles. The steam engine acts as a reducing valve but it's a reducing valve that generates power or drives equipment and then exhausts most of the heat units into your processing or heating lines.

The modern Troy-Engberg Steam Engine also offers the following advantages — wide speed range, high overload capacity, high starting torque, conservative speed, exceptional dependability. Investigate this drive for your stokers, fans, pumps, compressors and generators.

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(Established 1870)
2100 Railroad Avenue Troy, Pennsylvania

TROY-ENGBERG
STEAM ENGINES • GENERATING SETS • GENERATORS

ery as well as power plants will be obtained from the United States. The dam will be a massive concrete structure, 420 ft high and 6000 ft long. Excavation for the foundation of the dam will be approximately 22,500,000 cu yd, and it will mean laying 8,020,000 cu yd of concrete. The project is estimated to irrigate 2,000,000 acres of land and generate electricity equal to 100,000 kw with provision for doubling it.

Construction has began on the $150,000,000 Hirakud dam on the Mahanadi river near Sambalpur in Orissa. The dam will be 150 ft high and three miles long. Six irrigation channels will be taken out from the dam to irrigate over 1,000,000 acres of land annually. Hydro-electric power will be generated to the extent of 350,000 kw.

A multi-purpose project entitled The Demodar Valley project is expected to provide perennial irrigation for 800,000 acres and generate a peak load of 300,000 kw. When this is completed, boats will ply on the Hooghly up to the Ranigunj coal field area. About five million people in rural areas and two million in towns are expected to benefit directly from the project. A Damodar Valley Corporation modelled on the Tennessee Valley Authority is being created to administer the operations.

Among other projects are the Tungbhadra (120,000 kw) in Madras province, the Rihand (250,000 kw) in the United Provinces, and the Bhakra (300,000 kw) in the East Punjab, which will also provide high-level irrigation for approximately 5,000,000 acres.

G.E. RESEARCH LABORATORY HONORS FOUNDER ON EIGHTIETH BIRTHDAY

Dr. Willis R. Whitney, who founded the General Electric Research Laboratory in Schenectady in 1900 and directed its destinies until 1932, was honored on Aug. 21 on the occasion of his 80th birthday.

In ceremonies in the new Research Laboratory building now under construction at the Knolls, near Schenectady, Dr. William D. Coolidge, Director Emeritus of the laboratory, unveiled a painting of Dr. Whitney. Painted by Tran Mawicke, New York artist, the portrait will hang in the foyer of the laboratory's new home, which will be occupied this autumn.

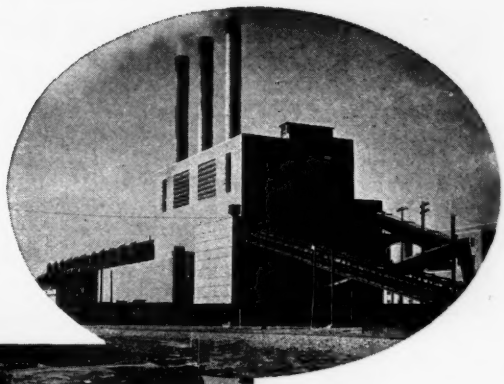
Opening the ceremonies, Dr. C. G. Suits, G-E Vice President and Director of Research, spoke of Dr. Whitney's contributions and read a number of testimonials from leaders in science and business. Dr. E. A. Luebke, president of the Whitney Club, an organization of laboratory personnel for social and recreational purposes, spoke on behalf of this group.

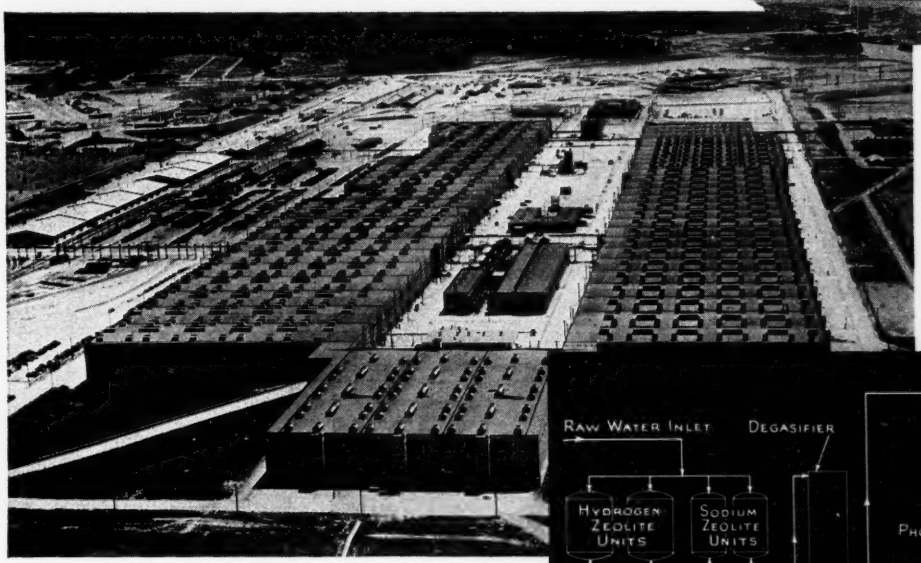
Dr. Whitney was born in James-

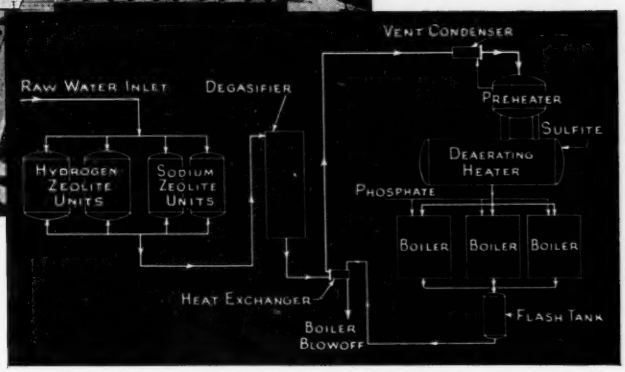
LIQUON

HELPS MAKE POWER AT

OAK RIDGE







Clinton National Laboratories at Oak Ridge, Tenn., is just one of scores of important plants where critical engineers have selected LIQUON equipment for water treatment.

Here, LIQUON equipment is used to treat boiler feedwater by means of:

- Hydrogen-Sodium Zeolite units —for hardness removal and alkalinity reduction
- Degasifier—for CO_2 removal
- Deaerating Heater—for oxygen elimination to less than 0.005 ml/litre
- Supplementary sodium sulfite and disodium phosphate treatment
- Continuous Boiler Blowoff equipment including heat recovery

Leaders in every industry come to LIQUON . . . for authoritative advice and sound engineering designs and equipment for handling boiler feedwater, industrial processes, and all types of water problems.

Three important elements of LIQUON service explain the uniform success of LIQUON installations:

1. the 35-year experience of the LIQUON engineers, backed by
2. a large, well-trained staff of designers, draftsmen and chemists, operating with extensive facilities which assure prompt, efficient service and backed by advanced research and proven field results
3. a *complete* line of processes, materials and equipment which assures impartial recommendations and modern designs.

Send the coupon for information on water treatment equipment in which you are interested.

LC-179

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A TRUE BALL JOINT Spherical grinding finishes the seats of a Dart into a true ball joint with wide, true-bearing surfaces. Because of this feature, Darts are easily made tight without jamming . . . without damage to seats.

TWO BRONZE SEATS The special bronze alloy used for Dart seats has a high resistance to pitting, electrolysis and corrosion . . . means years of leakproof protection.

PRACTICALLY INDESTRUCTIBLE Both body and nut of a Dart are made of high-quality, air-refined malleable iron to give extra resistance to stress and stretching . . . extra years of life under toughest conditions.

EXTRA-HEAVY SHOULDERS And lastly, to withstand more years of wrench abuse, the shoulders of a Dart union are made stronger and heavier.

When you add up these features it is easy to see why Darts can be used again and again . . . why Darts will bring you more years of trouble-free service.

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town, N. Y., August 22, 1868. He attended the Jamestown High School and then went to the Massachusetts Institute of Technology, graduating in 1890. From 1894-6 he studied in Europe; first at the University of Liepzig, winning the Ph. D., and then in Paris at the Sorbonne. For many years he served on the faculty of M.I.T., even after he came to Schenectady, holding a position as non-resident professor. Recipient of many of the highest awards and honors in scientific and engineering circles, he holds honorary degrees from Union College, University of Pittsburgh, University of Syracuse, University of Michigan and Lehigh University. In 1940, when he retired as G-E Vice President in Charge of Research, he was elected an Honorary Vice President.

RARE GAS IMPROVES EFFICIENCY OF NEW FLUORESCENT LAMP

KRYPTON, one of nature's rarest elements, has come into its own as the medium for lifting fluorescent lamp efficiencies still higher. Put to work in an 85-watt fluorescent lamp recently developed by the Westinghouse Lamp Division, it has a 17-per cent gain in efficiency over the generally used argon gas.

The new 85-watt, 60-in. long, 2⅛-in. diameter lamp provides as much light and burns as long as the 100-watt argon-filled lamp which it replaces and which it matches in good maintenance and other features. This reduction in wattage means that users can save 17-per cent on their electricity costs without lowering their light levels.

The use of krypton is a significant contribution to the steady improvements made in fluorescent lamps. Watt for watt, these tubular sources of cool, comfortable light now produce more than three times as much light as incandescent lamps.

The 85-watt krypton lamps have the same dimensions and electrical characteristics as the 100-watt fluorescent lamps and can therefore be used in present 100-watt fixtures.

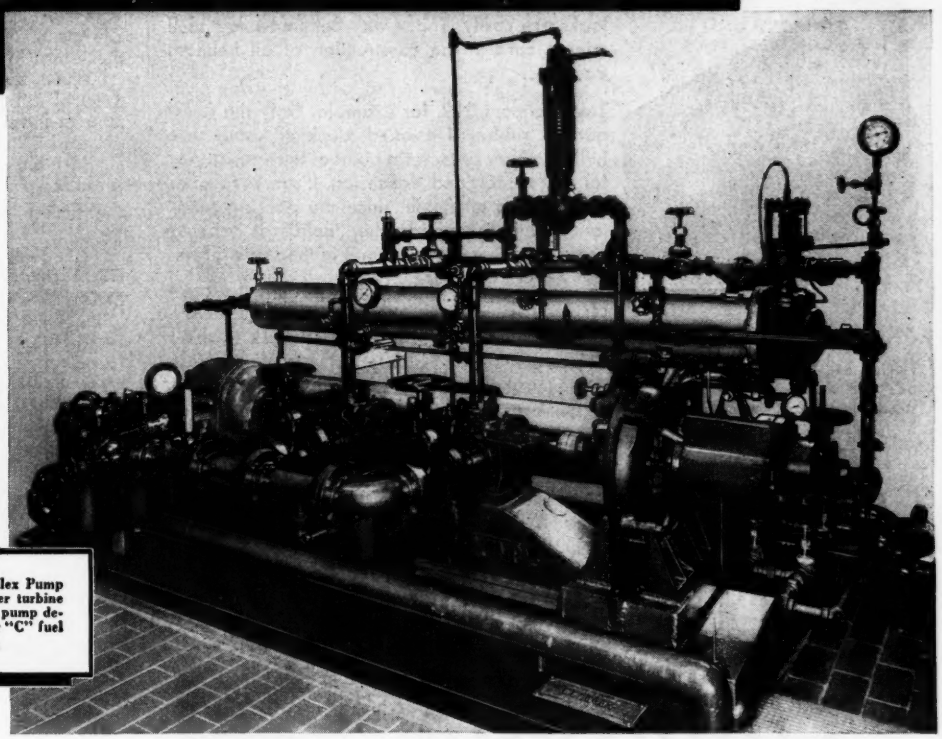
The decision to change to 85-watt krypton lamps climaxes studies begun more than a decade ago by Westinghouse lamp research men and engineers. In 1939 experimental fluorescent lamps utilizing krypton were made, but only recently has the gas become available in sufficient quantities for large-scale production at a feasible cost.

E. H. KRIEG JOINS STONE AND WEBSTER ENGINEERING STAFF

STONE & WEBSTER announces the appointment of Mr. E. H. Krieg as Consulting Engineer in their Boston office. For the last several years Mr. Krieg has been Chief Design Engineer of American Gas and Electric Corp., in New York.

Since his graduation from Cornell

DEPENDABLE, EFFICIENT and *Designed* FOR YOUR PLANT!



Typical Peabody Duplex Pump and Heater Set. Either turbine or motor driven screw pump delivers 12 GPM Bunker "C" fuel at 250 lbs. and 220°F.

. . . the completely automatic PEABODY FUEL OIL PUMP and HEATER SETS

Peabody Pump and Heater Sets, designed to prepare Bunker "C" or other heavy fuels for combustion, are the result of more than 25 years of research and engineering in oil combustion efficiency. Compact, complete and built to last, Peabody units are always specified when plant overhead must be minimized and modernized to meet today's rising costs. Available in a wide capacity range, *for all types of burners.*

Here are only a few advantages you get in a Peabody installation:

Each set designed to specific requirements • Compact, complete unit mounted on common base • Quick, easy installation • Clean fuel delivered to burners at proper temperature and pressure • All parts available for inspection and maintenance • Easily cleaned, with no "down time" • Minimum space required • Factory-built and tested, delivered ready to receive your plant service connections • Low-mounted pumps, minimum suction lift

Complete details on request. Write for Bulletin 150.

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BELMONT 319
Hollow Center Packing

For low and intermediate steam; hot and cold water rods and plungers; steam hammers and elevator plungers.

Philadelphia, Pa. No matter how small — power leaks are costly. That's why Belmont takes such minute care in the construction of all Belmont Packings.

Take Belmont 319, for example. Only the finest quality rubber frictioned duck is used. The hollow center provides a point of least resistance for contraction and expansion. It serves to keep friction at a minimum, since the packing tends to "breathe" towards the "hole" as varying pressures are exerted upon it in the stuffing box.

The construction of Belmont 9 permits the combination of two distinctive materials into one integral packing. The rubber and duck channel acts as a wiper and also a protection to the flax. The linen thread stitching prevents material displacement and buckling so frequently experienced in unstitched packings of this type

BELMONT PACKINGS

Belmont Packings are easy to obtain and convenient to see; distributors are located in every large center, with sample kits displaying Belmont materials and constructions.

Identification is simple. Belmont Packings wherever practicable, are packed in attractive and secure boxes, bearing our orange-colored trade-mark on a blue background.

The Belmont Catalog is available. This invaluable reference book reduces packing facts down to simplest forms. Write on your company letterhead for free copy.

Investigate how Belmont can serve you! Contact your local distributor or write us direct.

BELMONT 9
Special Hydraulic Channel Flax

For all hydraulic services from low pressure to extreme heavy duty, hot and cold water.

THERE'S A BELMONT PACKING FOR EVERY SERVICE

Steam, Water, Oil, Gas, Air, Acids, Alkalies, Ammonia

Rings, Spirals, Coils, Reels, Spools, Sheets, Gaskets.

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in 1922, Mr. Krieg has been continuously engaged in the design, maintenance and betterment of steam power stations and has originated many advanced practices in this field. He was employed by Sanderson and Porter from 1922 to 1925, by Electric Bond and Share Co. from 1925 to 1933 and has been with American Gas and Electric Corp. since that date. During that time he was responsible for the mechanical design of high pressure power installation totaling approximately 2,000,000 kw in capacity, including several units now under construction designed for operation at 2,000 psi and 1,050 F with reheat at 1,000 F. Mr. Krieg is a Fellow, ASME, a Member, AIEE, and has served for a number of years as a member of the Prime Movers Committee of EEI.

DR. L. W. CHUBB RETIRES FROM WESTINGHOUSE

DR. LEWIS WARRINGTON CHUBB, director emeritus of the Westinghouse Research Laboratories, has retired after 43 years of scientific research with Westinghouse, leaving behind him a record of outstanding contributions in nearly every field of science and engineering.

The veteran scientist, who served as director of the Laboratories from 1930 until assuming his honorary emeritus post last March, was awarded more than 150 patents covering inventions in radio, electronics, jet propulsion, telephony, electrical equipment, radar and many other fields. He has received nearly every major engineering and scientific honor.

Dr. Chubb joined Westinghouse immediately after being graduated from Ohio State University in 1905. In the years which followed he helped cut down high energy losses prevalent in electrical steels, and did important work in high temperature insulation. His novel electropercussive method of welding, still in use today, revolutionized the field of welding. He obtained the first American patent on grid-controlled arc inverters and vacuum oscillators. Dr. Chubb helped found the Westinghouse Research Laboratories in 1916. In 1920 he was named head of all the company's radio engineering activities, and he figured prominently in the establishment of KDKA, the world's pioneer broadcasting station.

During World War II, he was active in the development of jet propulsion, microwave apparatus, new types of torpedoes, fire control systems, and high-temperature alloys. Dr. Chubb was consultant on numerous important committees charged with the development of new military equipment and weapons, including the atomic bomb.

Last year Dr. Chubb was awarded the John Fritz medal, the nation's highest tribute to scientists and engineers.

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2D UNDERGROUND COAL GASIFICATION TEST

As REPORTED in the September issue, page 67, the Bureau of Mines and the Alabama Power Co. are making plans for a second and larger cooperative experiment in underground coal gasification this fall. A contract between the two organizations has been announced by James Boyd, director of the Bureau. Alabama Power Co. is providing some 300 acres of Pratt seam coal near Gorgas, Ala., and the new experiment will be in charge of Milton H. Fies, consulting engineer and manager of coal operations for Alabama Power Co. and James L. Elder, chemical engineer, Bureau of Mines.

Director Boyd estimated that the site-preparation work would be completed this fall.

Objectives of the experiment are:

1. To determine the quantity of coal which can be gasified from a given combustion zone and the shape and extent of the burned-out area formed.
2. To determine whether fixed outlets for product gas are practicable, either at the outcrop of the coal bed or at vertical bore holes. Various designs of inlets, outlets, and seals will be tested.
3. To determine the operating characteristics of the installation under a variety of conditions.
4. To determine the quality and quantity of product gas generated with an air blast under experimental conditions and, secondly, the quantity of tar and related products obtained.
5. To obtain information on the effect of heat on the overlying strata.
6. To obtain fundamental technical and economic information concerning plant sites, installations, and operating processes.

Last year's experiment produced encouraging results (POWER PLANT ENGINEERING, September, 1947). It was shown that combustion could be maintained and controlled, that coal in place could be gasified completely, and that the roof rock would become plastic, expand, and settle down behind the burning coal face without cutting off the air or gas. The gas obtained, however, was of lower heating value than desired. This was attributed to leakage of gas and air pressure through cracks and breaks in the thin (30 foot) cover over the burning coal seam.

To correct this fault, the new experiment will be carried out at a much deeper level—100 ft or more—and with much heavier air pressures and higher temperatures. These factors are expected to increase the average heat value of the gas produced with an air blast from the 47 Btu per cubic foot obtained last year to from 70 to 125 Btu. Oxygen and steam can improve the gas quality further, as was shown in the first field trial when runs made with an oxygen-enriched air blast, an oxy-

gen-air steam blast, and an oxygen-steam blast increased the average heating value of the gas produced to 50, 110, and 134 Btu per cubic foot, respectively.

Although of lower heating value than normal commercial gas, the product was burned successfully under a boiler. If available in quantity, it could be used to make electric power and perhaps for other industrial heating fuel requirements. If heating values can be improved materially, underground gasification offers a cheap source of synthesis gas—carbon monoxide and hydrogen—the No. 1 problem in making synthetic liquid fuels manufacture economic.

Under the plans, the parallel entries in the coal bed will be connected by a crosscut every 300 ft. At the center of each crosscut and at the end of the butt entry, a large-diameter vertical bore hole will connect with the surface. A refractory-type fixed gas outlet and seal will be constructed at the entry portals, and the vertical bore holes also will be sealed at the surface and fitted with pipe connections for attaching the air source and product gas incinerators, or gas-usage equipment.

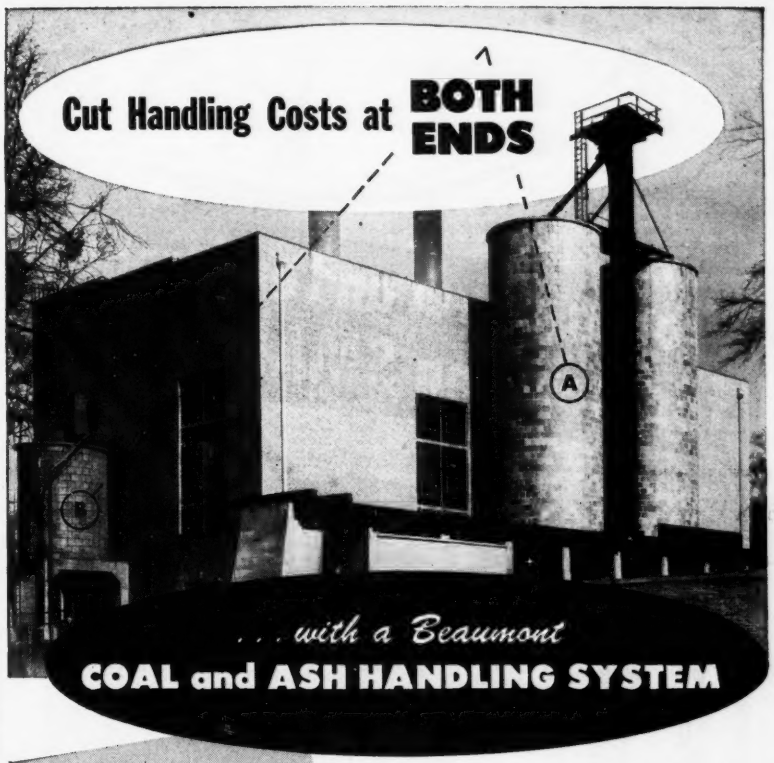
A fire will be started in the coal bed at the bottom of one of the bore holes by dropping an incendiary bomb down the casing as in the first experiment. Air will be forced down this bore hole under pressure by an electrically-driven reciprocating compressor with a capacity of 7,300 cfm. Gases will be drawn off at the next bore hole or one farther down the entry if desired. Temperature and pressure measurements taken at small test holes offset from the line of the entry will determine the progress of the fire.

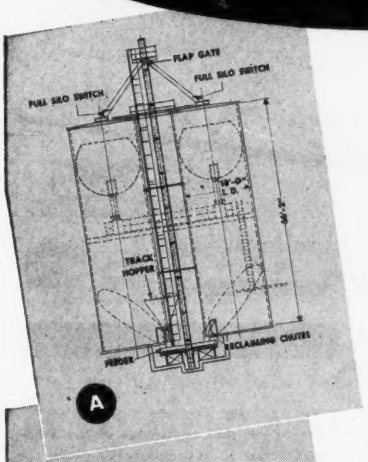
If, as expected, the coal burns out between the bore holes in a cigar-shaped cavity, additional bore holes will be drilled from the surface to the widest points of the cavity curves. These holes, in turn, will be connected to the system as air inlets. In this way, the possibilities of using a vertical bore hole system to propagate the gasification over a tract of coal land will be determined. If that method is unsuccessful, a parallel entry system or a modification thereof will be employed to continue the combustion.

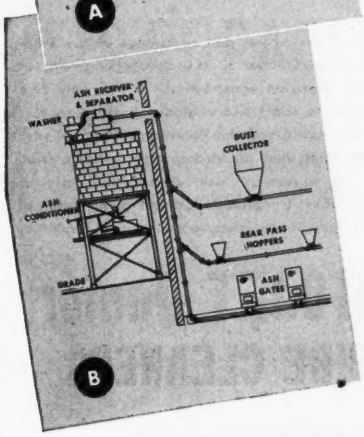
New ENGINEERING BOOKS

The Guarantee of Annual Wages by A. D. H. Kaplan; copyrighted 1947; size 5½ by 8 in.; stiff cloth binding; 269 pages; published by The Brookings Institution, Washington 6, D. C.; price $3.50.

Much discussion has been published in the public and industrial press on such questions as: Will annual wage agreements be a feasible next step toward increasing the financial security of the wage-earning population? What adjustments in the American economic system would be indi-







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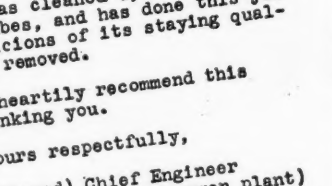

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cated if business generally were to adopt annual wage guarantees? In this book the author has presented a study which is primarily concerned with current proposals which would start with the guarantee of substantially full-time pay rolls as overhead, in the expectation that, by having to meet these guarantees, industry would find ways to stabilize production and give greater security at higher levels of employment. It considers the problems with which business would be confronted to meet this obligation—the impact on total employment, on competitive practices, and on business fluctuations that make for insecurity. It also indicates some of the supplementary measures which would be required to give reality to the guarantees. The book is divided into two parts—Part I dealing with the Background and Current Position. In this the chapter headings are: Expanding Objectives of the Annual Wage; Labor's Position on Guaranteed Annual Wages; Experience of Firms with Stabilization Plans; The Data of Economic Fluctuation. In Part II which deals with The Implications of Industry-Wide Guarantees the chapter headings are: The Management-Labor Relationship; Impact on Business Policy; Impact on the Economic Structure; The Role of the Government; and Summary of Findings.

• • •

Elementary Mechanical Vibrations, by Austin H. Church, 200 pages, illustrated; size 6 by 9 in., cloth binding; published by Pitman Publishing Corp., 2 West 45th St., New York, N. Y. Price $3.25.

To enable engineers and trained students to handle the usual problems in mechanical vibrations that arise in practical work, this text has been prepared to give the basic material required for the solution. The author feels that this may be done more successfully by sacrificing mathematical rigor and relying on a physical explanation of the phenomena in most cases.

This book is intended only to give an introduction to the subject, for much more extensive study is required of the specialist in vibration, and many vibration problems arise which call for the use of advanced mathematics and extensive experiences possessed only by specialists. Nevertheless, many vibration problems arise that may be avoided in design or may be cured by a rational application of the elementary principles explained here.

A good working knowledge of algebra is needed to use this text, but, except in a few cases where theory must be explained, there is very little higher mathematics. Many specific examples are worked out numerically.

The book opens with discussion of definitions and terminology and simple harmonic motion, then takes up undamped free vibrations and undamped forced vibrations of single degree of freedom and damped free vibrations and damped forced vibrations. The remaining chapters deal with undamped vibrations, two degrees of freedom; multimass torsional systems, equivalent torsional systems, multimass lateral systems and balancing. The book is indexed and well illustrated with line diagrams and sketches.

• • •

Boiler Fireman's Handbook, by Joseph R. Darnell, first edition; 192 pages, 139 illustrations; size 6 by 9 in., simulated leather binding; published by Technical Publishing Co., 53 W. Jackson Blvd., Chicago 4, Ill. Price $3.00.

Based on his 30 years' experience in power plant practice, the author here provides boiler firemen and power plant engineers with data for solving many of their combustion problems. It also offers many helpful suggestions for the successful operation of various units of equipment found in the power plant, and manipulated or supervised by the operators.

Most of the material in this book was published serially under the same title in POWER PLANT ENGINEERING (now POWER GENERATION) during 1944 and 1945.

The book begins with a review of the fundamentals of combustion; subsequent chapters offer specific calculations in combustion problems involving solid, liquid and gaseous fuels.

The practical and immediate nature of the book is indicated by some of the chapter titles. One is—Why Flue Gas Temperature Goes Up When the CO_2 Goes Down.

Another outstanding chapter is that entitled, Boiler Efficiency Calculated from Flue Gas Analysis and Temperature. In this chapter curves and tables show how calculations of flue gas weights and volumes are made, as well as boiler efficiencies, for various types of fuel. Simple charts and tables permit quantities to be read

directly without calculation and the answers obtained by simple arithmetic, without higher mathematics.

After discussion of details of the operation of various types of fuel firing equipment, including firing of waste fuel, the author concludes with a final outstanding chapter on Flexibility in Firing Equipment and Problems Involved in Converting from One Fuel to Another. That subject was extremely timely during the war, when this series was published, and was included for that reason. Today, for reasons growing out out of the war conditions, and others added to them by difficulties with post-war fuels, it is becoming timely again.

This book is addressed specifically to men on the firing aisle of industrial boiler plants, and not to designers of equipment. It is well illustrated with diagrams and line drawings. There is an index and at the end a bibliography of helpful reference works.

• • •

Instrument and Control Manual for Operating Engineers, by Eugene W. F. Feller; 426 pages, illustrated; size 6 by 9 in., cloth binding; published by McGraw-Hill Book Co., 330 W. 42nd St., New York 18, N. Y. Price $6.00.

For a long time a book of this type has been badly needed, in both the fields of power plant design and operation. Much of the literature on instruments and controls deals with the theories of control and too little of it with the practical equipment used in solving specific metering and control problems. This book meets the latter need very successfully. It explains the basic principles of control and instrumentation, describes the construction and operation of liquid level, pressure, temperature, speed and humidity indicators and controllers. After dealing with the individual units that make up a complete control system, the author shows how they are connected together and how the operation of one unit effects that of another.

He devotes considerable space to explaining the operating fundamentals of each primary element and one of the outstanding features of the book is in the illustrations. There are practically no photographs in the book but the various details are made very clear by detailed drawings, cross-sections and diagrams of the equipment.

The subject is covered under the following chapter headings; Simple Liquid-Level Instruments; Pressure Elements; Head Meters for Liquid Level, Pressure, and Flow; Temperature Elements; Characteristics of Motor-operated Valves; Self-operated Pressure Valves; Temperature Valves; Hygrostats and Psychrometers; Control Mechanisms; Control Systems; Controller Applications; Emergency Instruments; Feedwater Control; Mechanical Governors; Hand Valves and Piping; Traps and Condensate Systems.

• • •

Nomography, by Alexander S. Levens; 176 pages, 120 illustrations; size 6 by 9 in., cloth binding; published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York City. Price $3.00.

Nomograms or charts are widely used in scientific and technical work to save time in repeated solution of mathematical formulas. The alignment chart, a type of nomograph, has been widely used during the past 20 years and illustrates the convenience of the form.

Engineers and scientists should be trained to understand the mathematical design and theory of nomograms and know how to construct them for use in their own work and that of others.

In this book, the author places emphasis on the geometric method employed in developing the theory for design of alignment charts involving equations of 3 or more variables. Simple equations are solved by alignment charts consisting of straight-line scales, whereas more complicated equations may necessitate the use of grids, curved scales and combinations of Cartesian co-ordinates with alignment charts.

Once the theory is well understood, practical short cuts are presented to reduce the time required to design a chart. A number of examples of these are given a separate chapter.

The chapter on the use of determinants introduces a method that has been developed by a number of other writers. An appendix contains practical examples of alignment charts in engineering, production and statistics.

The author is professor of mechanical engineering at the University of California at Berkeley, has had wide and varied experience both in teaching and in actual engineering practice and has incorporated this experience into his discussion of nomographs.

• • •

Combustion Engineering, edited by Otto de Lorenzi, contributions by 30 engineers; more than 1000 pages, 400 illustrations, 80 tables; size 6 by 9 in., heavy buckram binding; published by Combustion Engineering Co., Inc., 200 Madison Avenue, New York 16, N. Y. Price $7.50. (Special price to engineering students and instructors.)

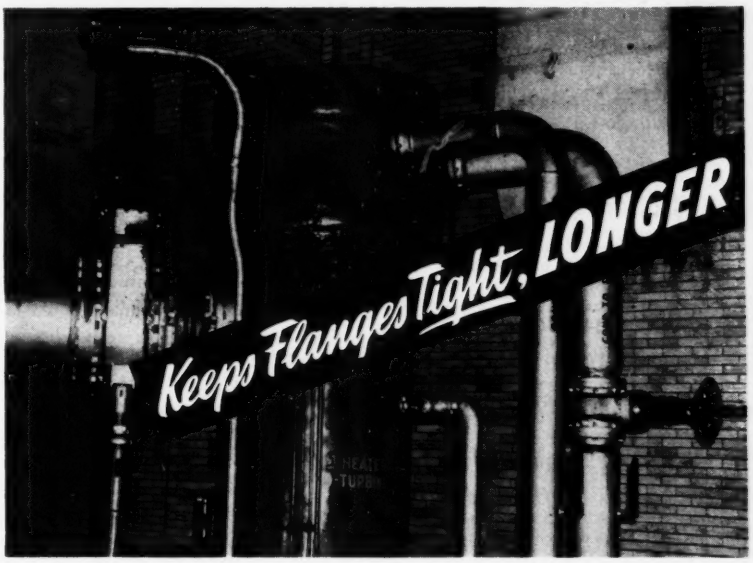
This is one of the best written, best organized and most comprehensive works yet published on the subject of combustion engineering, which is defined in the book as "the science of burning fuel to liberate heat and make it available to perform useful work." The combustion engineer is one skilled in the art of burning fuel; frequently he is also a designer of fuel burning, steam generating and related equipment. These definitions indicate the scope of the work. It is the result of several years of work by 30 members of the staff of Combustion Engineering Co., headed by Otto de Lorenzi, director of education for the company. The names of many of these men are familiar to power engineers, for they have written much in **Combustion** magazine and the other magazines in the power engineering field, and are prominent in the activities of the ASME.

In our opinion, they have done an outstanding job of covering the methods and equipment used in combustion engineering. The book should be of the highest value to the designing and operating and consulting engineer, also to executives who must evaluate recommendations.

Each chapter is self-contained, hence there is some repetition in text and illustration. This, however, is not serious, and the self-contained arrangement makes it possible in future editions to keep abreast of changes and new developments.

Merely reading the list of chapter headings does not give an adequate idea of the comprehensive treatment given in this book.

The preface begins by calling attention to the need for designing fuel burning equipment to utilize wide ranges in fuel qualities, to secure greatest economy at lowest cost and contribute to fuel conservation. The opening chapters on origin and production of coal and fuels for steaming purposes contain many specific data on the characteristics of the various fuels for steaming purposes, tests for various characteristics, burning characteristics, and influence of ash in combustion. Details of methods and typical examples of combus-



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tion calculations are given in full, using both the weight method and the mol method. Following this are chapters on the various types of stokers, including single and multiple retort underfeed, spreader stokers, chain and traveling grate stokers. Many boiler cross-sections are given showing details of the settings of these stokers and their relation to the entire boiler installation.

The chapter on pulverizers and pulverized fuel burners contain much practical information on the relation between grindability, fineness, mill capacity, air temperatures, etc., besides giving many details of the equipment. There is a chapter devoted especially to furnaces for coal firing, dealing with the various types of furnaces used, factors in design for various fuels and various types of boilers, design of wall cooling surfaces, etc. Similar information is given on burners and furnaces for liquid and gaseous fuel, also for wood refuse and bagasse.

Following this there is a very fine chapter on fluid cycles, including the mercury cycle. Chapters are given on the construction details of all types of fire tube and water tube steam generating units, and this is followed by a treatment of superheaters and desuperheaters showing equipment and its operation for the control of steam temperature by the various methods now in use in modern plants. Heat recovery equipment, such as air preheaters and economizers, is covered fully.

There is an outstanding chapter on selection of equipment designed to show how plant owner and equipment manufacturer may properly select and co-ordinate fuel burning and steam generating equipment.

One of the best and most useful chapters in the book is that on performance calculations for a steam generating unit, approaching it primarily from the point of view of the designer. Instruments, controls and interlocks are treated. A feature of this discussion is the number of boiler cross-sections marked to show location of proper and necessary instruments.

The final chapters deal with operation and maintenance of equipment and there is a good discussion of modern boiler manufacturers. The appendix contains many tables of coal data, a complete steam table for saturated and superheated steam, heat balance data and many useful charts and tables all calculating combustion. A full size Mollier Diagram is included at the back of the book.

Outstanding in the book are the large number of line drawings showing complete boiler settings, details of boilers and firing equipment, and auxiliaries, and a chart of relations between various combustion factors. There are many complete boiler cross-sections of recent installations in well-known stations.

• • •

Introductory Problems in Engineering, by C. W. Crawford; 122 pages, illustrated; size 6 by 9 in., paper binding; published by Irwin-Farnham Publishing Co., 3201 S. Michigan Ave., Chicago 16, Ill. Price $1.75.

For a long time, engineering schools have been trying to find some way of giving to students entering engineering courses an idea of the nature of engineering principles and work. This book has been written to accomplish that purpose. The book has been planned to show the students the types of problems he will meet in engineering and the kind of thinking required.

It begins with an introductory chapter on the place of the engineer, the functions of the various types of engineers, their professional responsibility, and the student's approach to engineering. Then follows specific discussion of exponents and logarithms, the slide rule, dimensional equations, notes on trigonometry, motion, principles of mechanics, equilibrium and friction, uniform acceleration, work, energy and power.

An appendix gives tables of common logarithms, sines and cosines, weights of common substances, properties of common areas and solids. The book should be quite useful in introducing a student to the types of problems engineers have to solve, so that he can determine for himself just how much he is interested in them. Whether or not he has the required aptitudes for engineering is another problem entirely, but at least if he finds a book like this interesting, he will be justified in asking for more detailed and professional help in making up his mind about a career in the profession.

• • •

Centrifugal and Axial Flow Pumps, by A. J. Stepanoff; first edition; 428 pages, illustrated; size 6 by 9 in., cloth binding; published by John Wiley and Sons, Inc., 440 Fourth Ave., New York City. Price $7.50.

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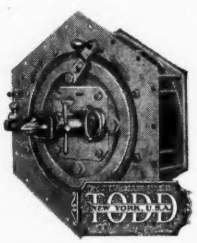

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To make possible the advance in pump design referred to above has required much theoretical and experimental study of cavitation, operation outside the normal head capacity and speed range, axial and radial thrust, effect of stuffing boxes on the critical speed of pump shafts, control of head-capacity and brake-horsepower curves; and pumping of viscous liquids.

The theoretical treatment of the centrifugal pump impeller as presented in this book differs radically from that found in existing works on the subject. The flow through the impeller is resolved into a meridianal flow, caused by the energy gradient drop, and a circular motion that may assume one of the many possible forms of vortex motion. The single pattern of flow, thus arrived at, makes it easier to deal with a number of formerly controversial issues.

The book should be very valuable as a working manual for consulting engineers and plant designers. It covers the subject under the following chapter headings: Selected Topics from Hydraulics; Definitions and Terminology; Theory of the Centrifugal Pump Impeller; Vortex Theory of Euler's Head; Specific Speed and Design Constants; Design of Mixed Flow Impellers for Centrifugal Pumps; Pump Casing; Axial Flow Pumps; Hydraulic Performance of Centrifugal Pumps; Leakage, Disk Friction, and Mechanical Losses; Axial Thrust; Cavitation in Centrifugal Pumps; Special Operating Conditions of Centrifugal Pumps; Special Problems of Pump Design and Application; Shaft Design for Critical Speeds; Special Problems and Applications of Vertical Turbine and Axial Flow Pumps; Special Problems and Applications of Centrifugal Pumps; and Centrifugal-Jet Pump Water Systems.

• • •

Report on Oil-Engine Power Cost for 1946; 40 pages, 8½ by 11 in., paper binding; published by the American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y.

Like its predecessors, this report gives information on performance and production costs of oil-engine power plants.

In the Report for 1945, only 112 plants were covered because wartime conditions and postwar readjustments had restricted the number of plants that found it possible to co-operate. The trend is now reversed and there is a substantial increase in the number of plants reporting their data, so that in the current report 126 plants are covered.

Moreover, this upward trend in the number of plants reporting indicates a recognition by Diesel plant operators of the value to them of these reports, to the extent that they are again expending the time and effort necessary to submit the required data.

• • •

Heat, by Archie G. Worthing and David Halliday; 522 pages, illustrated; size 6 by 9, cloth binding; published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16; price $6.00.

The authors, professor of physics and assistant professor of physics, respectively, at the University of Pittsburgh, have presented here the fundamental laws and principles involved in transformations associated with heat. Experimental methods are emphasized and sometimes various methods of measurement of the same physical quantity are described.

Precision and consistency in definition has been aimed at, and the symbols are treated as physical quantities rather than as numerics, a common but not a general policy. The authors have distinguished between temperature and temperature difference and assumed the equality of the various expressions for a given temperature regardless of the units used.

They have also introduced a different conception of the difference between mass and weight by using the verb "to mass" and the verb "to weigh."

Considerable knowledge of algebra and some higher mathematics are necessary in reading this book. But to those having this knowledge, it will be worthwhile because it presents modern conceptions of

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heat and its usage. In the chapter on the dynamical theory of heat, for example, the authors trace the growth of various conceptions of heat energy; and later in the book they refer many of the practical operations of working equipment to the fundamental principles.

Analysis of just what heat transformations occur in steam engines, turbines, refrigerating equipment, gas turbines, etc., are given and there is a good discussion of the modern conception of radiant energy.

The treatment is given under the following chapter headings: Some Laboratory Procedures; Temperature and Its Measurement; The Expansivities of Solids and Liquids; The Dynamical Theory of Heat; Calorimetry; Specific Heats of Solids and Liquids; Thermal Conduction of Solids and Liquids; Thermal Properties of Gases; Elementary Thermodynamics; Change of Phase; Heat Engines, Refrigerators, and Human Power Plants; Convection; Radiant Energy.

• • •

Heaviside's Electric Circuit Theory, by H. J. Josephs, with a Foreword by W. G. Radley; 4 by 6½ in.; 113 pages; cloth; published by Methuen & Co., Ltd., 36 Essex Street, Strand, W. C. 2, London, England.

While this is not a new book, it makes available to electrical engineers the more important work of Heaviside's Electric Circuit Theory.

As electrical engineering develops, circuits become more complicated and the growing importance of transient effects makes problems harder to solve. It is evident, therefore, that the electrical engineer must learn to use more powerful mathematical tools. One of the most useful for the analysis of electric circuits is the Heaviside Operational Calculus. This is, in effect, a simple shorthand technique for evaluating the results of Fourier integral analysis.

This book was prepared at the suggestion of Professor Willis Jackson of Manchester University, with the needs of electrical engineering students in mind. It is based on an out-of-hours course of lectures delivered by Mr. Josephs to engineers at the Post Office Research Station. The scheme adopted in the original lectures and closely followed in this book is to base electric circuit theory on a far-reaching theorem which so far appears to have escaped the notice of engineers. This theorem has been reconstructed from the scattered papers of Heaviside and is probably the last he ever deduced. For this reason the author has called it Heaviside's Last Theorem. The famous Carson integral equation may be obtained as a corollary to this theorem. It also leads to many others involving Fourier and Bessel integrals, elliptic functions, etc., which have a wider field of application than electric circuits.

• • •

Kinematics of Machines, by Leon Marr Sahag; first edition; 249 pages; 6¼ by 9 in.; illustrated; cloth; published by The Ronald Press Co., 15 East 26th St., New York 10, N. Y.; 1948. Price $4.00.

The increasing demand for new and improved machines for use in industry makes it necessary for colleges to teach the fundamentals of certain engineering courses in such a manner that they meet present-day needs. Mechanics, as one of the basic courses, should be so taught that it includes all the material necessary to enable students to enter on their work as engineers. As one branch of Mechanics, Kinematics should receive its due share of attention. It should be so taught as to include adequate information about motions as applied to new and better machines. In former days, though the design of slow-speed machines did not require such careful consideration of methods of solving problems involving velocities, accelerations and similar factors, the machines as constructed then gave satisfactory service. Today, however, and especially where high-speed machines are concerned, the matter of obtaining accurate results with respect to velocities and accelerations is of great importance and in consequence deserves careful study.

In an engineering course in Kinematics, we are primarily interested in displacements, velocities and accelerations regardless of the types of mechanisms of the machines involved. More can be accomplished, however, and the importance of Kinematics will be more clearly brought out if the study of these topics is carried out in conjunction with links or simple mechanisms. Mere theory or explanations made only with line diagrams with no reference to a mechanism will have little value for practical purposes. It is for this reason that in this volume the author has divided the text into separate chapters—instant centers, gears, an so on; and in

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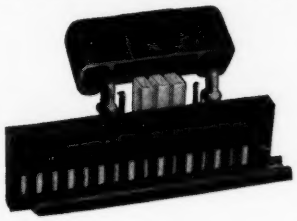

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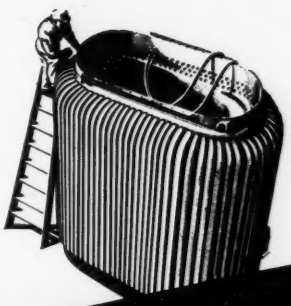

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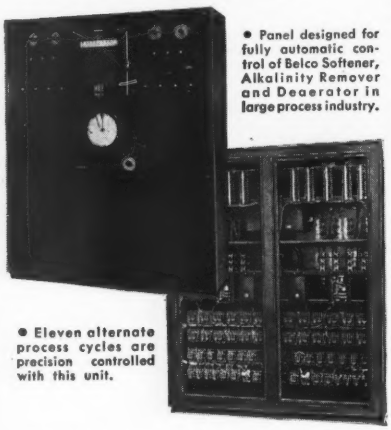

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each chapter the study of motions relative to particular mechanisms is discussed in detail. The author is Professor of Engineering, Drawing and Design at the Alabama Polytechnic Institute.

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Fluid Mechanics of Turbomachinery, by George F. Wislicenus; first edition; 5½ by 8 in.; 613 pages; illustrated; cloth; published by the McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York; 1947; price $7.50.

This is an authoritative treatment of flow problems encountered in the design of water, gas and steam turbines, centrifugal or axial flow pumps and compressors, propellers and hydraulic torque converters and couplings. While the book is primarily designed for practical use by mechanical, automotive and aeronautical engineers, it gives full and careful attention to advances in the field of fluid mechanics as far as they can be applied to the theory of turbomachinery. The presentation is subdivided into similarity consideration, the one dimensional theory of turbomachinery and the mechanics of compressible fluids. The problem of geometrical form of design is thoroughly discussed. While it is essentially a textbook suitable for senior and graduate students, it is also very valuable for engineers who are engaged in the design of turbomachinery or in research and development work in any of the fields covered. While it cannot be considered an elementary introduction to general fluid mechanics, those principles of this field which have been used in the book are derived independently of other publications. In this manner the book has been made a self-contained unit.

Work on the material in this book began over 15 years ago at the California Institute of Technology under the influence of Dr. von Karman. Most of the specific work was done while the author was connected with the Worthington Pump & Machinery Corporation. The author's present connection with the Packard Motor Car Co. offered a possibility to adjust the text in some places with respect to recent developments in the field of compressors and gas turbines.

• • •

The Diary and Sundry Observations of Thomas Alva Edison, Edited by Dagobert D. Runes; 5½ by 8½ in.; 248 pages; illustrated; cloth; published by the Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y.; 1948. Price $4.75.

The diary of Thomas Alva Edison, which is presented in this book for the first time, is only fragmentary and so are many of the chapters of his observations and notes. Thomas Edison was not a desk scientist. His mind was forever searching for new paths, new ways into the mysteries that surround us, and many a precious secret was he able to wrest from nature. His book knowledge was scattered, sporadic and unsystematic; he was almost entirely self-educated. He would read the Police Gazette one hour and the Journal of Higher Mathematics the next. The editor in this book has endeavored to present to the reader a selection of Edison's social and philosophic ideas taken from the available notes, statements and observations of the inventor. The reader will find that many of Edison's casual remarks made many decades ago, have a definite contemporary significance. His propositions in ethics, philosophy, music and education show a rare combination of whimsey and deep sincerity.

• • •

Thermodynamics, by Lester C. Lichty; second edition, 1948; 340 pages, 160 illustrations; size 6 by 9 in., cloth binding; published by the McGraw-Hill Book Co., 330 W. 42nd Street, New York, N. Y. Price $4.50.

In the first edition of this book, it was pointed out that thermodynamics has so baffled the average student that it has acquired the undesirable reputation of being too difficult for any but the most gifted. The book was originally written to simplify the treatment and eliminate many of the mathematical manipulations.

To accomplish this the author consolidated the treatment into logical groupings from the standpoint of thermodynamic analysis rather than mechanical equipment. He also attempted to establish a better balance between vapor and combustion processes.

In the second edition, the same general arrangement has been retained, since it proved effective in the first, but much of the text has been rewritten to clarify the more difficult parts. The chapter on properties of mediums and processes has been divided into two, and a section on nonsteady flow processes has been added. Also, a section on gas turbine is now included. The chapters on availability of energy and

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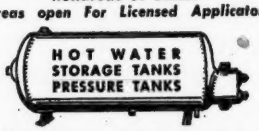

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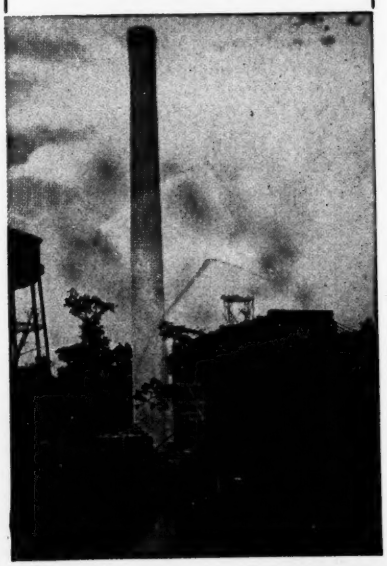

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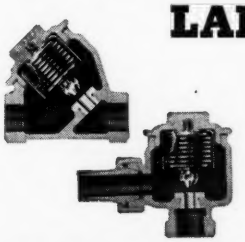

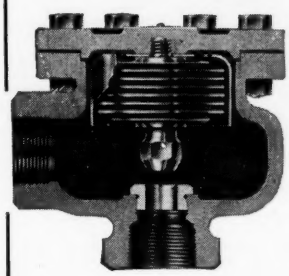

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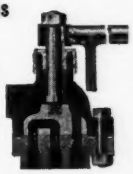

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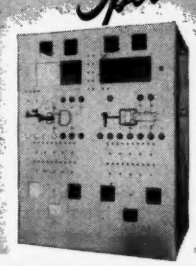

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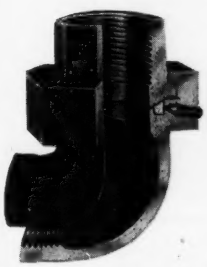

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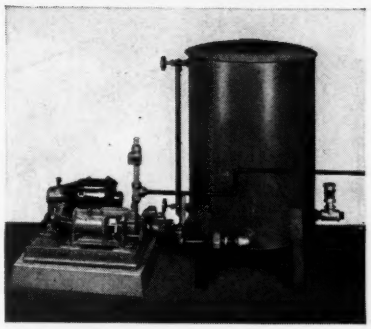

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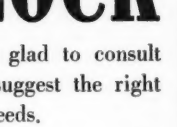

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on flow of fluids have been rewritten. The latter, on flow of fluids, includes material dealing with supersonic flow, Mach number, shock, jet, and rocket propulsion and the Moody friction chart. More diagrammatic sketches of apparatus arrangement have been introduced and many more exercises are included at the end of each chapter.

The author is professor of mechanical engineering at Yale University.

• • •

TechniData Hand Book, by Edward Lupton Page; 64 pages, illustrated; 5½ by 8½ in., cloth binding; published by the Norman W. Henley Publishing Co., 17-19 W. 45th Street, New York City.

This book is a condensed, classified summary of usable information on the fundamental exact sciences. As a student, the author says that he found himself carrying around too many books and spending too much time looking in them for information that proved to be scattered elsewhere. Accordingly, he compiled for his own use the data contained in this book.

It is made up of notes, formulas, diagrams and tables in the fields of mathematics, physics and chemistry, also of engineering mechanics. It gives such things as formulas in trigonometry and analytic geometry, with tables of logarithms, powers and roots, etc. Formulas in physics are given with tables of constants and relations in the various systems, coefficients of expansion, velocities of sound, electromagnetic wave lengths, etc. Corresponding formulas and tables in chemistry and mechanics are included.

• • •

Turbines, Condensers and Their Auxiliaries, 1945; Publication No. P-8; 45 pages, illustrated; size 8½ by 11 in., paper binding. **Boiler Auxiliaries 1946-1947, Publication No. P-10;** 25 pages, illustrated; size 8½ by 11 in., paper binding. Both publications of the Prime Movers Committee, Edison Electric Institute, 420 Lexington Ave., New York 17, N. Y. Prices No. P-8 $1.00 to members and P-10, 70 cents to members.—$2.50 and $1.75, respectively, to non-members in U. S. A.—$2.65 and $1.90, respectively, to foreign countries.

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Committee on Turbines, Condensers and Their Auxiliaries, contains comments from operating companies and statements by manufacturers on the following subjects. 1. Evaluation of effects of high load factor operation during the war, and postponement of usual, normal inspection and maintenance work, and observations on the results of this situation in causing unusual, excessive maintenance. 2. Improving balance or reducing noise in turbines. 3. Number of machines installed or ordered on standardized basis. 4. Usual reports of turbine troubles, blading difficulties and other operating experiences. Also information on generator air coolers.

The majority of the companies reporting on the effect of high wartime load factors on maintenance, indicate no major difficulties due to extending the operating time between overhaul periods. Improvements in balance and substitution of the flexible generator mounting have made marked reduction in vibration and noise level.

Only 9 of 39 recent turbines ordered were to the preferred standard.

Blading and other miscellaneous troubles were reported by 13 companies.

The report includes statements by only 3 manufacturing companies—Bailey Meter Co., General Electric Co. and Westinghouse Electric Corp.

Publication No. P-10 on Boiler Auxiliaries, 1946-1947, presents data on induced draft fan wheel and housing life, induced draft fan conditions, variable speed drives, boiler feed pumps, coal handling and allaying coal dust, boiler feedwater regulations. In addition to these statements on these points from many operating companies, there are manufacturers' statements from Allis-Chalmers Mfg. Co., Ingersoll-Rand Co., Worthington Pump & Machinery Corp., Johnson-March Corp., Bailey Meter Co. and Northern Equipment Co.

The statement of Johnson-March Corp. gives some detailed information about products used in allaying coal dust and an automatic flow proportioner cartridge utilizing water pressure for applying the material.

An interesting and detailed table based on data from operating companies shows boiler feed pump design specification. This covers method of operation, materials, valving and speed control practices.

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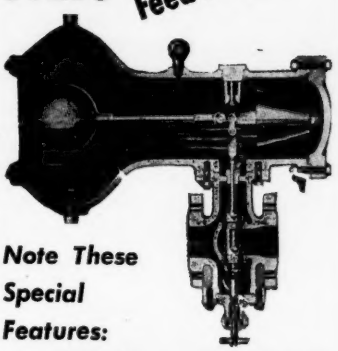

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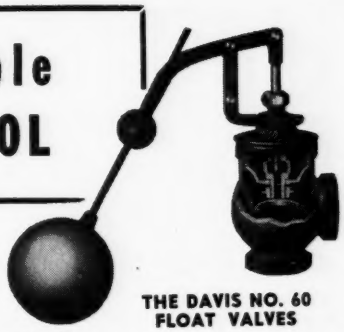

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POWER PLANT *Construction News*

Alaska, Fairbanks—Alaska Railroad Co., Anchorage, Alaska, plans new steam power plant at railroad shops at Fairbanks. Also will build a one-story shop for maintenance and repairs of Diesel locomotives. Entire project reported to cost over $400,000.

Calif., Oxnard—Santa Clara Citrus Assn., Oxnard, plans boiler house in connection with new lemon-packing plant on local site, comprising several one-story buildings. A cold storage and refrigerating plant also will be built. Entire project will cost about $400,000. Work scheduled to begin soon. W. W. Ache, 301 N. Citrus Ave., Los Angeles, Calif., is architect.

Fla., Keystone Heights—Clay Electric Cooperative, Inc., Keystone Heights, has plans under way for new power plant, with installation to include Diesel engine-generator units and auxiliary equipment. No estimate of cost announced. Proposed to begin work soon. E. P. McLean Engineering Co., Moultrie, Ga., is consulting engineer.

Ga., Whitesburg—Georgia Power Co., Atlanta, Ga., has plans maturing for new steam-electric generating station on Chattahoochee River, opposite Whitesburg, where site recently has been selected. Initial installation will include turbine-generators, with rating of 100,000-kw, high pressure boilers and auxiliary equipment. Plant is being designed for ultimate capacity of 400,000-kw. Proposed to begin work soon and to complete project in 1950. Cost estimated about $10,000,000, with transmission lines, power substations and other operating structures.

Ill., North Chicago—Abbott Laboratories, Inc., 1400 Sheridan St., North Chicago, industrial and other chemicals, has plans for new steam-generating plant at factory, 78x78 ft. No estimate of cost announced. Work is scheduled to be carried out at early date. Walter F. Shattuck is company engineer.

Ind., Jeffersonville—Bd. of Directors, County Hospital, Jeffersonville, has plans for new boiler house for central steam-heating service at institution. Cost reported about $75,000, with boiler units and accessories. William C. Findt, Elsby Bldg., New Albany, Ind., is architect.

Iowa, Denison—Town Council has plans under way for extension and improvements in municipal steam-electric generating station, with installation of additional equipment. No estimate of cost announced. Bids are expected to be asked soon. Lutz & May, Finance Bldg., Kansas City, Mo., are consulting engineers.

La., Baton Rouge—Gulf States Utilities Co., Louisiana Div., Baton Rouge, will proceed at once with substructure for new addition to local steam-electric generating station, with superstructure to follow in near future. Installation will include new turbine generators, high-pressure boilers and auxiliary equipment. Completion is scheduled early in 1950. Cost reported to $15,000,000. Main offices are at Beaumont, Texas.

La., Jonesboro—Town Council has plans under way for extensions and improvements in oil engine-operated municipal power plant, including installation of new Diesel engine-generator unit and auxiliary equipment. Cost reported about $295,000; bond issue is being arranged in that amount. Pan American Engineers, Inc., Alexandria, La., is consulting engineer.

Me., Augusta—Central Maine Power Co., Augusta, is arranging financing in amount of $8,500,000 for expansion and improvements in generating plants and system, continuing a development program which has been in progress for several months. New work will include power station facilities, substations, transmission lines and miscellaneous work.

Mass., Brockton—Brockton Edison Co., 36 Main St., has arranged fund of about $2,375,000 for extensions and improvements during next 28 mos., including generating station facilities, power substations, transmission lines, and other work.

Minn., Twin Lakes—Dairyland Power Co., La Crosse, Wis., has plans under way for new oil engine-operated generating station at Twin Lakes, where site has been selected. Installation will include Diesel engine-generator units, with auxiliary equipment, entire project to represent a reported investment of $1,000,000. Proposed to begin work soon.

Mo., Boonville—Bd. of Directors, Missouri Training School for Boys, Jefferson City, Mo., has plans under way for expansion in power plant at institution at Boonville, with installation of two new steam-electric generators, each 200-kw

rating, and auxiliary equipment. Proposed to ask bids soon. Marshall & Brown, 114 W. 10th St., Kansas City, Mo., are architects and engineers; W. L. Cassell, 912 Baltimore Ave., Kansas City, is mechanical engineer.

Neb., Bridgeport—City Council has approved plans for new municipal power plant to cost about $250,000. Bond issue has been authorized in that amount. Work scheduled to be carried out at early date. W. F. Chaloupka is city engineer.

Neb., Ord—Electric & Water Dept., Ord, has plans nearing completion for expansion and improvements in oil engine-operated municipal power station, with installation of new 1000-kw Diesel engine generator unit and accessory equipment. Entire project estimated to cost about $250,000. Lutz & May, Finance Bldg., Kansas City, Mo., are consulting engineers.

N. C., Hendersonville—Cranston Print Works Co., Cranston, R. I., textile bleaching, dyeing, printing, etc., plans boiler plant in connection with new branch mill at Hendersonville, where tract of land has been acquired. Project will comprise a number of buildings and is reported to cost close to $3,500,000. Work on superstructure will begin soon.

N. C., Leaksville—Duke Power Co., 422 S. Church St., Charlotte, N. C., has plans under way for new steam-electric power plant on Dan River, near Leaksville, to be equipped for large capacity. Cost reported approximately $15,000,000, with turbine-generators, high-pressure boilers, and auxiliary equipment, power substations, transmission lines and other operating facilities.

N. C., Roanoke Rapids—Virginia Electric & Power Co., Richmond, Va., plans new power dam and hydroelectric generating station on Roanoke River, near Roanoke Rapids, where site has been selected. Station will be equipped for an initial capacity of 65,000-kw, with project to include an artificial reservoir, about 8 sq mi for water supply. Entire project is estimated to cost approximately $18,000,000, including switching stations, power substations, transmission lines and other operating facilities. Application has been made for permission to Federal Power Commission, Washington, D. C.

Ohio, Kenton—Timken-Detroit Axle Co., 100 Clark Ave., Detroit, Mich., automobile axles and gears, plans boiler plant in connection with proposed new factory on site near Kenton, where large tract of land has been secured. It will comprise a number of one-story buildings equipped for large output. A power substation will be built. Entire project reported to cost over $3,500,000.

Pa., Philipsburg—Dept. of Property and Supplies, Harrisburg, Pa., plans new boiler house and mechanical laundry plant at State Hospital at Philipsburg, reported to cost approximately $250,000. Proposed to carry out work soon. A. F. Jones is chief engineer for department.

Tenn, Memphis—Memphis Light Gas & Water Div., City Hall, has plans under way for expansion and improvements in power substations at South Gate and other parts of city, with installation of transformers, switchgear, and auxiliary equipment for increased output. Cost reported about $1,250,000. Day & Zimmerman, Inc., Packard Bldg., Philadelphia, Pa., is consulting engineer.

Texas, Dallas—Dallas Power & Light Co., 1506 Commerce St., is considering an expenditure of about $5,000,000 for generating equipment and accessories for installation in local power plants. Application has been made for authority to proceed with project.

Texas, Merkel—Taylor Electric Cooperative, Inc., 304 No. Front St., plans new 600-kva power substation, in connection with construction of new transmission lines. Fund of $460,000 has been secured through Federal aid for project and work is scheduled to begin soon.

Texas, Paris—Larmar County Electric Cooperative Assn., Paris, has preliminary plans under way for new generating station. Proposed to use Diesel engine-generating units and accessories. Cost reported about $150,000.

Wash., Wapato—Yakima Fruit Growers' Assn., Wapato, plans new cold storage and refrigerating plant in connection with proposed rebuilding of local fruit packing plant, recently destroyed by fire, with loss reported over $200,000. Work scheduled to begin soon.

Wis., Abbotsford—Whitehouse Milk Co., has plans nearing completion for new addition to boiler house at plant, with installation of new boiler unit and accessories. No estimate of cost announced. Proposed to begin work soon. G. A. Krasin, 121 S. Central Ave., Marshfield, Wis., is architect.

Wis., Green Bay—Wisconsin Public Service Corp., Green Bay, will begin work on superstructure for new addition to local Bayside steam-electric generating station. Installation will include new turbine-generator, high-pressure boilers and auxiliary equipment, with cost reported about $5,250,000. Pioneer Service & Engineering Co., 231 S. La Salle St., Chicago, Ill., is consulting engineer.

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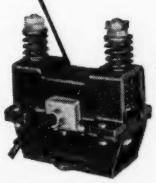

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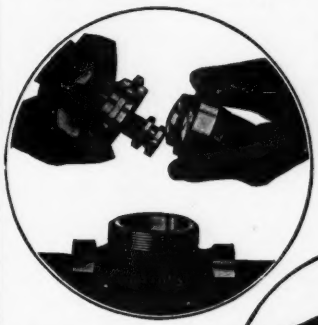

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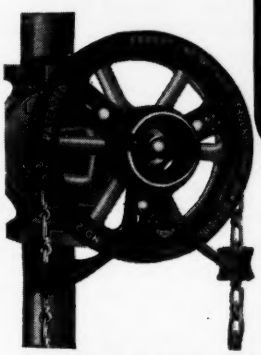

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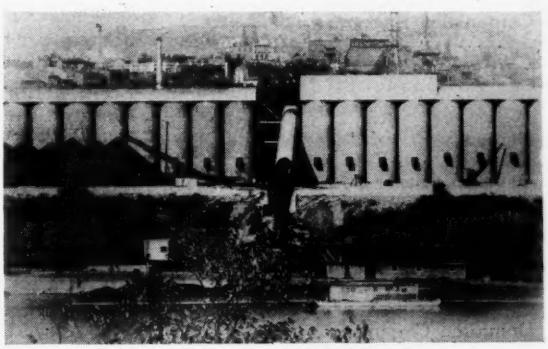

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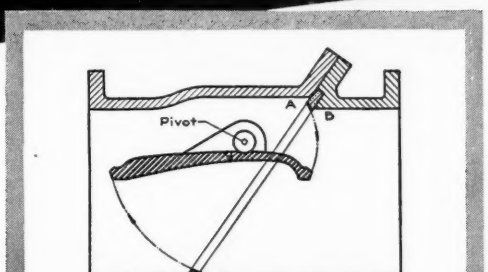

Cross-section of the Chapman Tilting Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

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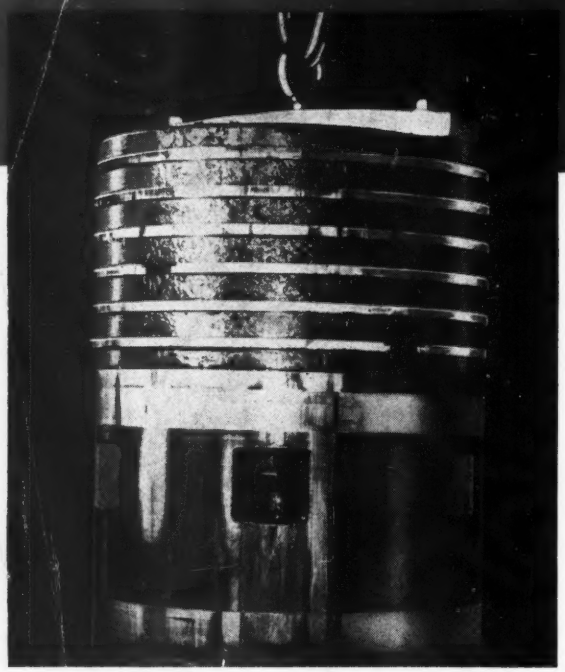

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